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N°. XVII.

REPORTS

ON THE SURVEY

OF THE

MINERAL DEPOSITS IN KUMAON,

AND ON THE

IRON SMELTING OPERATIONS

EXPERIMENTALLY CONDUCTED AT

DECHOUREE.

Calcutta:

Thos. JONES, "CALCUTTA GAZETTE" OFFICE.

1856.

No. 2658 A. OF 1855.

FROM

WILLIAM MUIR, ESQUIRE,
Secy. to Govt. of the N. W. Provinces,

TO

J. W. DALRYMPLE, ESQUIRE,
*Offg. Secy. to the Govt. of India,
Home Department,
Fort William.*

*Dated Head-Quarters, Camp Challa,
The 26th December 1855.*

DEPARTMENT OF PUBLIC WORKS.

SIR,

In continuation of my letter No. 2363 A., dated the 20th ultimmo, I am directed to transmit to you, for the purpose of being laid before the Most Noble the Governor General in Council, copies of the papers noted in the margin, being Mr. Sowerby's Weekly Reports of the Iron Tracts in Kumaon.

I have the honor to be,

SIR,

Your most obedient servant,

W. MUIR,

Secy. to Govt., N.W. Provinces.

*Head-Quarters, Camp Chatla, }
The 26th December 1855. }*

MR. SOWERBY'S REPORT OF THE SURVEY OF THE IRON
DEPOSITS IN THE BHABUR, &c.

A THOROUGH exploration of the Bhabor Iron Fields having been resolved upon, Mr. Sowerby, an Engineer, late in the employ of the East Indian Railway Company, was selected for the duty, and the Lieutenant-Governor of the North-Western Provinces now submits a Report of that gentleman's proceedings from the 22nd September to the 8th December last.

Several localities have been examined by Mr. Sowerby, some in company with Lieutenant-Colonel Drummond. Of most of these a favorable opinion is entertained, but for a proper understanding of the peculiar advantages possessed by each, it will be necessary to refer to the Reports themselves, as it is intended in this abstract to notice only the more important localities and any general suggestions which are offered by Mr. Sowerby.

The mines of Nutowa Khan Agur, it is stated, yield in large quantities an exceedingly rich description of "Micaceous Specular Iron Ore." Close to the mines are beds of lime-stone, and excellent fire-stone. The mines themselves are well situated, being near the high road and having the advantage of the Ramghur stream, which never becomes dry. The timber in the immediate neighbourhood has been used up, but the surrounding Hills are thickly covered with oak trees.

Mr. Sowerby has examined an iron mine at Oojoulee, near the Western end of the Loha Kôt, which was occasionally worked by the inhabitants to some extent. The ore is stated to be a rich red oxide of a specular appearance and is embedded in a micaceous clay slate with white crystalline lime-stone. The beds are not regular, and situate at an elevation above the Kessilla River of about 3,000 feet. Half way down the Hill, there being a mountain stream, which never becomes dry, the ore could be brought down by means of inclined drops or spouts with facility and economy.

The iron ore near the Khyrna Bridge is stated to be a rich red haematite, like the ores in Cumberland and Lancashire. It is not in regular beds, but large caverns. The enclosing rock is clay slate, exceedingly hard and compact. From all appearances, the deposit is very considerable, and there is a good back Hill to work upon. Timber is abundant in the neighbourhood, and the Kossilla River will supply water to any extent.

The Pass behind Chenur is considered one of the best routes for connecting the mines of the Agur District with those of the Bhabur. The Pass is low and quite practicable for a pony or bullock road. He cannot speak of the possibility of making a tramway to be worked by water-wheels.

In Dechouree, farther up the Boer stream, he has found a bed *in situ* exposed to a thickness of about 20 feet and upwards, at about half a mile beyond the previously ascertained beds. The works at Dechouree

are now being steadily proceeded with, and all descriptions of works there are in fair progress. In the District between Dechouree and Ramnuggur, there are no indications of iron-stone, nor up the Kossilla River as far as Duckalee. The jungle from Dechouree to Bhoonka has been cleared, and iron ore found on both sides of the deposit at Dechouree in large masses and of good quality.

Mr. Sowerby has selected convenient sites on the Southern side of the Boer stream for an experimental furnace ; but the river is said to be very low during the dry months, owing to its heavy discharge in its various parts. The supply of water, he states, may be kept up by bunds or compensating reservoirs, or by having high falls and large wheels, and bringing the water down in well-constructed brick culverts. Before constructing the bunds and reservoirs, Mr. Sowerby recommends the retentive or porous character of the ground, the slope and other important circumstances to be carefully decided upon. A small auxiliary steam engine might, he thinks, be used during the dry months. This will entail a small additional expense, fuel being abundant and cheap. The works, he adds, ought to be carried on in different places, in order to prevent the rapid consumption of fuel in one particular part of the forest.

Near the village of Bhuggur a ferruginous bed has been discovered. Though at its exposed part, it is not a proper iron-stone, but more like clay-stone, with good deal of iron, it requires to be dug into to prove its true character.

From Loha Bhur Bhur to Derealkara, there are seen for a distance of about 300 feet blocks of brownish-ton. At several places the stone is seen out cropping, but not much exposed. Here is also found white fire-clay.

The iron ore near Bhoonka has been traced until it terminates in a high precipice. The precise dimensions of the bed cannot be stated until the jungle is cleared, which is being done. Huge blocks are found opposite the village of Bhoonka.

A path has been cut through the jungle, from the high scar at the West end of Loha Bhur Bhur towards Bhoonka, and a bed in large masses has been discovered in three different places. It is a rich brown iron ore of a metallic appearance when fractured. Mr. Sowerby attaches much importance to the finding out of these beds, as it settles the question as to the character of Loha Bhur Bhur deposits and their continuity.

A bed of clay iron ore has been discovered at Beejapoer, near Hulwance, of 30 feet in thickness. A level is made on the hill-side for a distance of about 100 feet, which is through iron ore and iron soil, and there are indications of the bed being continuous longitudinally. The iron ore is rather rich, but more friable than the beds of Loha Bhur Bhur and Dechouree. It is slightly metallic when broken, and small flakes of white clay matter are interspersed in the bed. Immediately beneath the bed is one of white fire-clay. There is limo-stone at places within 2 or 3 miles of the mine, and a stream below the bed of iron ore, which is small and becomes dry in the hot weather, but the Golah River, which is 2 miles distant, can supply any amount of water power. The fuel is abundant and the unhealthy part of the jungle is already cleared, and the country towards the Plains is open.

The first result of clearing of the jungle has been the exposure of the bed of iron ore on both sides of the above-mentioned small stream. On the right bank the bed is of considerable thickness and the ore is of good quality, but covered with detritus, which is being removed. The advantages of Beejapoer render it peculiarly adapted for works on an extensive scale for smelting and manufacturing of iron.

At Chownsilla he has found in two dry streams small rolled blocks of iron-stone, which he has traced to their original bed in a ravine in the Hills, 2 miles North of the high road. The blocks when fractured have a very metallic lustre, are heavy, and contain a good percentage of iron. Here also he met with white clay and a thin seam of coal. Similar seams were noticed at Bumooarce above the dawk bungalow and up the Boer River. The coal would be exceedingly useful for railway purposes, and therefore an investigation is desirable.

Owing to the density of the jungle he has not been able at present to examine the deposits to the Eastward of Hulwance. He will be better able to do this in a month hence, and till then would confine his researches to the Westward.

In the neighbourhood of the Kossilla River, and immediately after crossing the dry bed of the Dubka, an iron bed is seen in a ravine, and in a North-west direction the bed is successively seen out cropping in several places to the North of the village of Umraihee (Ghorai Kot,) and lower down towards the river the bed is exposed to a thickness of about 20 feet from Umraihee to Banranee Nuddee, East of Dat Kot. The ore is a brown clay, kind of a slight metallic lustre when fractured; it is

poor, but the specimens in thicker parts of the exposed bed are rich and heavy. The ore is often spotted with pea-like crystals. Mines are being dug to ascertain the true character of the deposit in this locality. The specimens from the Western bank of the river are heavy and resembles the best quality of Beejapoor ore. The local position of the ore on the Kossilla is adapted for the establishment of large works. Hackeries can go higher up, and the water power is great.

In a ravine branching off from the Khuddharee Nuddee, close to Ghora Kôt, iron-stone is found in huge blocks to a considerable distance and in large quantities. The ore is a red and brown clay iron ore. The Khuddharee Nuddee is nearly dry. There is lime-stone in the neighbourhood and a dense forest all round. This discovery is considered important, being between two large streams. Water in the Kitcheree is considerable, at the point where works would be erected. From works established there, the bed of iron ore would be easily brought down by tramway laid from the mines. The discovery of the continuity to the Westward may be regarded exceedingly satisfactory.

Near a place called Bhora Kôt, some few specimens of iron ore have been found, and beyond Bhora Kôt there are large blocks of highly ferruginous quartz rock, with a great deal of iron ore. Some are exceedingly rich and heavy, but being mixed with quartz of a crystalline character, it will be refractory in the furnace, and may prove useful for mixing with other ores. No bed has been discovered, but the indications are favorable.

At Latee Bullena, some ferruginous quartz, with iron ore, has been discovered. The specimens obtained below the surface are of a deep crimson color resembling cinnabar; being associated with quartz, it is refractory, but may be useful in mixing with the very fusible ores of the newer rocks.

Mr. Sowerby has examined the plumbago deposits in several localities in the neighbourhood of Almorah, where openings had previously been made, and where plumbago, either of an inferior kind or that of the best quality, in very small quantities, have been found. The extent of the country over which there are indications of this mineral is about 15 miles. The formation is a highly micaceous clay-slate. In many places the ground is greatly dislocated and disturbed, a circumstance which renders mining difficult and requires great skill and judgment. The openings have been superficial and never carried to an extent to prove

the true character of the deposits. The ground therefore should be thoroughly explored, and mining on a proper plan would prove successful, it carried on by persons acquainted with this particular work. He has advised Colonel Drummond to suspend it until he could superintend the work himself, or employ some competent person to do so.

At Chownsilla alum has also been found as an efflorescence on the rocks (sand-stones.)

Mr. Sowerby speaks very favorably of the laborers who have worked under him, and expresses a hope that they will hereafter prove useful as miners.

(COPY.)

No. 108 OF 1855.

From

J. H. BATTE^N, Esquire,
Commissioner of Kumaon,

To

W. MUIR, Esquire,
Secy. to Govt. of the N. W. Provinces.

Dated Camp Kaleedoongre, the 25th November 1855.

GENERAL DEPARTMENT,

PUBLIC WORKS.

Sir,

I HAVE the honor to forward for the information of the Honourable the Lieutenant Governor of the North-Western Provinces the accompanying Report of Progress by Mr. W. Sowerby on special duty in this Province.

I have the honor to be, &c.,

(Signed) J. H. BATTE^N,

Commissioner.

KUMAON COMM'R'S OFFICE; }
Camp Kaleedoongre, }
The 25th November 1855. }

(COPY.)

HIMALAYAN IRON WORKS, KUMAON.

PROGRESS REPORT OF THE SURVEY OF THE IRON DEPOSITS IN THE BHABUR, &c. BY W. SOWERBY.

HAVING received instructions to further investigate the deposits of iron ore in the Lower Hills, the following is a Report of Progress made in this Survey from the 22nd September up to the 14th of November.

Owing to the reputed unhealthy state of the Bhabur during the latter part of September and the early part of October, together with the difficulty of obtaining laborers there during that period, I was strongly advised to defer proceeding there then.

At the suggestion of Lieutenant-Colonel Drummond, I accompanied him into the interior of the Province to examine the iron deposits, a short distance within the Hills, with the view of ascertaining their extent and the practicability of economically working them in connection with the mines of the Bhabur.

On the road from Nynce Tal to Alnorah, about one-quarter of a mile Iron indication near Sham Ket. on this side of Sham Ket, I noticed a ferruginous bed indicating an iron deposit, and a short distance beyond the stream where the native houses are situate, I picked up a small piece of iron-stone of tolerable good quality.

About 2 miles beyond the Ramghur dawk bungalow, near the high road, I was shown several pits, which had been dug by the native miners for obtaining iron ore, specimens of which I obtained. It is an exceedingly rich description of micaceous specular iron ore, and is said to be obtainable in any quantity, which I consider highly probable. The Ramghur stream had plenty

Water power. of water in it for water power, and from enquiries on the spot it never becomes dry. A bed of

Lime-stone. lime-stone I also noticed *in situ* and excellent fire-stone, both a short distance from the iron mines. The timber immediately over the mines has been used up by the native smelters, but the surrounding Hills are thickly covered with oak trees, forming a dense forest from the Ramghur stream to the summits of the highest peaks. This is in the Agur District.

Timber.

When at Alnorah, I was requested by Lieutenant-Colonel Drummond Plumbago deposits to examine the plumbago deposits in the sur- near Alnorah. rounding neighbourhood. The first indications of plumbago is the black appearance of the soil in numerous places, especially on the Harredongee Hill and on Kaleemut. I went over to the village of Pulseemee, where openings have been made, in order to try the ground, and out of which an inferior kind of plumbago has been obtained. I continued my examination up the Valley of the Sal River as far as the village of Pathownee, where several other openings had been made, and from which the best quality of plumbago has heretofore been obtained, though in very small quantities. I picked out several good pieces from the rock. Beyond Kaleemut I visited several other openings, where the results arrived at had been similar to those at Pulseemee. The extent of country over which these plumbaginous appearances and indications are found is very considerable, probably 15 miles. The formation is a highly micaceous clay-stale. The ground however is in many Places greatly dislocated and disturbed, thereby rendering the mining much more difficult, and consequently requiring very great skill and judgment. The openings that have been made were done to try the ground, and though in many places they go a great way in, they are still comparatively superficial, and in no case have they been carried on to an extent to prove the true character of the deposits, or to enable any one to say that the mineral can be obtained, either in quantity or quality, to be worth working or otherwise. The ground should be more thoroughly explored, and wherever it is found comparatively settled, mining on a proper plan, and to a sufficient extent, would I believe prove successful. The spot for commencing operations must be carefully selected by some one acquainted with this particular kind of mining, and the work must be well directed. Without this is done, I fear that partial attempts would lead to nothing satisfactory, but would act as a discouragement to future efforts; I therefore advised Lieutenant-Colonel Drummond to suspend my further work until he either had time at his disposal to superintend the work himself, or until it was placed in the hands of some person who was competent to do so.

I next proceeded down the Valley of the Kossila, accompanied by Mines of iron at Oo- Lieutenant-Colonel Drummond, and Mr. Davies, joulee. the smelter. At Oojeulee, near the Western end of the Loha Kôt or Iron Mountain in the Agur District, we examined an iron mine occasionally worked by the inhabitants. The ore is a

rich red oxide of a specular appearance, and is found embeded in a micaceous clay-slate, accompanied with white crystalline lime-stone. The bed or beds have been partially worked, but to no great extent. They are exceedingly thick, but not very regular, and situated at a very great elevation above the Kossilla River, probably 3,000 feet and upwards. About half way down the Hill the path crosses a mountain stream which never becomes dry, and may at some subsequent period become serviceable for water power. Bringing the ore down from so great an elevation would not be accompanied with much difficulty, as it could be brought down by means of inclined drops or spouts, similar to the coal spouts on the Tyne, with great facility, and at a comparatively trifling expense.

I next visited a deposit of iron ore near the Khyrna Bridge : this is
 Iron deposits at Khyr- at the confluence of the Ramghur and Kossilla
 na. Rivers. The ore is a rich red haematite, precisely
 similar to the same ores found in Cumberland and Lancashire : it is
 not found in regular beds, but large caverns. The ore has been worked
 slightly by the native miners, as seen in several irregular openings made
 by them close to the bridge. The enclosing rock is clay-slate, exceedingly
 hard and compact ; the ore is seen in several places in a high scar
 facing the river ; and from the extent to which it is seen, I have no doubt
 whatever, but that the deposit is very considerable, and there is a good
 "back" (hill) to work upon. This mine has been the subject of noto-
 riety from the circumstance that the materials for the iron bridge were
 brought from England, and one end of it is built into a rich mine of
 iron. Timber is abundant in the neighbourhood of the mines last men-
 tioned, and the Kossilla River will supply water to any required extent,
 being a very large stream.

From Khyrna, I went up to the village of Jâk, to examine the Pass
 behind Chenur. The Pass being, according to the
 opinion of Lieutenant-Colonel Drummond, one of
 the best routes to be taken for connecting the mines of the Agur District
 with those of the Bhalur. The Pass appears low and quite practicable for
 a pony or bullock road, but I cannot yet give a decided opinion on the
 possibility of making a tramway to be worked by water-wheels, as sug-
 gested by Lieutenant-Colonel Drummond.

From Jâk I proceeded again to Dechouree and continued the research
 The mines of Dechou- farther up the Boer stream, with a view of ascer-
 ree. taing the continuity of the bed in that direction

beyond the point mentioned in my previous observations respecting this deposit, and the result was the finding of the bed *in situ* exposed to a thickness of about 20 feet and upwards. This was at a point about half a mile beyond the previously ascertained beds. I also noticed a slight indication high up the hill-side to the Eastward of the beds already described in my former observations.

I accompanied Mr. Davies and Lieutenant-Colonel Drummond to fix

Site for an experimental furnace. upon a site for an experimental furnace. At the Dechoureo side of the river there were many difficulties to contend with, that it was considered advisable to fix upon the opposite side of the river, on one of the natural terraces of level ground. On this side there is a succession of terraces, with narrow strips of level ground rising gradually from the bed of the river until they attain an elevation of about 150 to 200 feet. Each strip is from 30 to 40 feet higher than the other and these strips of land are cultivated and irrigated by a succession of small streams or gools formed by the cultivators. It was therefore considered advisable to fix on a site close to one of the streams of water, which would greatly facilitate the making of the experiment and lessen the expense.

In selecting the Southern side of the river, it was considered that great facilities were afforded in gaining access to the Plains and in establishing residences for European head-workmen. The facility, too, with which a succession of furnaces could be built at the sides of the steep banks or steps and the ready means of getting a natural fall of water, the same water being used for driving a succession of wheels, and finally allowed to pass on to the land for irrigation, rendered the Southern side of the river by far the most desirable. It now appears that the quantity of water in the

Water power in the River Boer becomes exceedingly small during the dry months, namely April and May, when it is said to be but 10 cubic feet per second. The exact quantity however does not appear to be precisely known, as there are many contradictory statements. This is I think owing to the discharge being various in different parts of the river, according as the bed is retentive or otherwise ; and immediately opposite the village of Dechoureo the bed of the river is very porous and the stream becomes small, whereas higher up it becomes larger, though narrower and more impetuous ; and lower down, where the new canal is taken off, it is said to be equal to 50 cubic feet per second.

Something, however, may be done in the way of bunds and compensating reservoirs placed laterally for keeping up the supply of water, and a great deal may also be done by making the most of a small supply by having high falls and large wheels and bringing the water down in well-constructed brick culverts to prevent evaporation and escape. By this means the water will probably be sufficient to work the machinery of four or six furnaces. (They should be erected in pairs.) The construction of bunds and reservoirs is attended with some difficulty, depending greatly on the retentive or porous character of the ground, the slope and other important circumstances; and before being decided upon, they should be well considered, and should form part only of some complete arrangements and plans, otherwise they may prove useless and do a great deal more injury than good. A small auxiliary steam en-

Auxiliary steam power might be used during the dry months. This would entail only a small additional expense, especially where fuel is so abundant and cheap. It is not desirable to have all the works concentrated on one spot, where a rapid consumption of fuel would take place, whilst other parts of the forests would remain untouched. It will therefore be found to be no inconvenience to have the works carried on in different places, and before long, communication will be opened out to points on the banks of large rivers, as the Kossilla and Rangunga and Golah, where water power can be obtained and where fuel is abundant, though iron-stone may be scarce; and the additional expense of transporting the ore on common tramways will be found no serious expense in the production of iron.

At a distance of about 3 miles up the River Boer, near the village Iron bed up the Boer of Bhuggur, a highly ferruginous bed has been River at Bhuggur. discovered, exposed by the action of the river.

It is not at its exposed part a proper iron-stone, but more of the character of a clay-stone, containing a good deal of iron. It looks very metallic when fractured. This bed will require to be dug into to prove its true character.

I have now traced the iron bed from the Loha Bhur Bhur to Dereekara, where the blocks of brown iron-stone are seen up the side of the Hill for a distance of about 300 feet and a length of about five chains (say 300 feet.) An opening had been made here by Lieutenant-Colonel Drummond, but it is now fallen in at several places intermediate. Between Loha Bhur Bhur

and Derealkara the stone is seen out cropping, but not very much exposed. Here also I have found the white fire-clay.

To the Westward of the previously ascertained bed at Loha Bhur

Iron ore near Bhoon-ka. Bhur, the ore has been traced until it terminates in a high abrupt scar or precipice of solid iron

ore. The bed has heretofore been seen only on its longitudinal face. At this precipice, however, a cross section can be seen, which shows it to be of great extent, but the precise dimensions of the bed cannot be properly stated until the jungle is cleared, which is now being done. The bed has also been partially traced until opposite the village of Bhoonka, where the huge blocks are found exactly as at Loha Bhur Bhur.

I have examined the deposit at Beejapoar, where Lieutenant-Colonel Beejapoar, near to Hubli-waree. Drummond had made an opening. This however

had fallen in. This opening I have since my first visit had again opened out, and the result is the exposure of a bed of iron ore (clay iron ore) of at least 30 feet in thickness. A level has been driven into the hill side for a distance of about 100 feet, the whole of which is through iron ore and iron soil. The bed is quite undisturbed and unbroken, and the ground settled. Several smaller openings had been made by Lieutenant Colonel Drummond on each side of the larger one, where the bed was again come upon, and I found several small blocks of the iron ore in dry ravines at distances of five or six chains on each side of the large opening clearly indicating the bed to be continuous longitudinally. I have directed the jungle to be cleared, and further openings to be made forthwith. The iron ore is rather rich, but more friable than the beds of Loha Bhur Bhur and Dechouree. It is slightly metallic when broken, and small flakes of white clayey matter is interspersed in the bed. Immediately beneath the bed is a bed of white fire-clay. Lime-stone is obtainable at several

Lime-stone. places within a distance of 2 or 3 miles of the

mine. There is a stream immediately below the bed of iron ore, which is only small, and becomes dry, or nearly so, during the hot weather, but the Golah River, which is only 2 miles distant, is sufficient to supply any amount of water power that may be required. The minimum discharge is about 200 cubic feet per second in the dry months, and as this river derives its supply, not only from the drainage of a large area and numerous springs, but also from Nynee Tal, Boehm Tal, Non Kutchea Tal, and Mulooa, it may be assumed that the supply is

never likely to fail, but that it might be very considerably increased if necessary. The fuel here is as abundant as at any other part of the Bhabur, and the unhealthy part of the jungle is already greatly cleared; and towards the plains the country is beautifully open and free from obstruction. The many advantages of this place appear to point it out as peculiarly adapted for the establishing of works on an extensive scale for the smelting and manufacturing of iron. This however will be more completely discussed in a final Report.

At Chownsilla, a village half way between Huldwanee and Kalecoongee, in two dry streams I found small rolled blocks Chownsilla iron ore. of iron-stone. The specimens first found appeared to have been carried some distance by the river. I have now traced these blocks to their original bed, which I found in a ravine in the Hills about 2 miles North of the high road. The blocks near the bed are about 2 cubic feet in size, and when fractured have a very metallic lustre. They are heavy and contain a good per-centage of iron, but not equal to Dechouree. They differ also from other Bhabur specimens I have yet seen, in being associated with a good deal of silicious matter. The bed is but little exposed, and will require to be excavated. Here also I found the white clay, and close at hand I found a thin seam of coal. I also

Coal. noticed similar seams at Bumouree above the dawk bungalow and likewise up the Boer River. The coal resembles, and is, I think, a lignite, though occasionally slightly bituminous, but it appears only in short irregular thin patches, and nothing like regular beds. The abundance of wood fuel renders it unnecessary to search for coal for smelting purposes, but it would be exceedingly useful for railway purposes. It would therefore be very desirable to fully investigate these coaly appearances.

At Chownsilla, I have also found alum appearing as an efflorescence Alum. on the rocks (sand-stones.) I am not aware of the value of this mineral in India, nor have I examined as yet into the probable supply—it may, however, be worthy of notice in passing.

With regard to the deposits to the Eastward of Huldwanee, the Destrts to the East. jungle is just at present so very dense, that it ward of Huldwanee. would be difficult to penetrate it. The statements of Lieutenant-Colonel Drummond in his Report have however been proved to be so faithful and correct at all places which I have visited,

that there need not be the slightest hesitation in relying fully upon whatever statements he has made in his Report with regard to the deposits to the Eastward; and as these can be much better visited a month hence, it would appear advisable to continue the research at present to the Westward on ground already unexplored.

The works at Dechouree are progressing favorably ; the greater part of the timber and wood-work is cut and dressed ; the Dechouree experiment. foundations are now being dug for the furnace, and an excellent stone quarry has been discovered close at hand.

I cannot close this Report without expressing my satisfaction at the excellent character of the laborers. In the course of one week fourteen men had executed an amount of labor at the Beejapoore mine to such an extent, that it augurs well for their future usefulness as miners, and for success of future works.

(Signed) W. SOWERBY,
Engineer in charge.

KALEEDOONGEE, }
The 14th November 1855. }

(COPY.)
No. 441 OF 1855.

FROM

J. H. BATTEN, ESQUIRE,
Commissioner of Kumaon,

To

W. MUIR, ESQUIRE,
Secy. to Govt. of the N. W. Provinces.

Dated Camp Kaleedooongee, the 30th November 1855.

GENERAL DEPARTMENT,
PUBLIC WORKS.

SIR,

I HAVE the honor to forward a Weekly Report of Survey, &c. from Mr. W. Sowerby, Engineer in charge.

I have the honor to be, &c.,
(Signed) J. H. BATTEN,
Commissioner.

KUMAON COMM'R'S OFFICE ; }
Camp Kolecdooongee, }
The 30th November 1855. }

(COPY.)

HIMALAYAN IRON WORKS, KUMAON.

PROGRESS REPORT OF SURVEY, &c. FOR THE WEEK ENDING 24TH
NOVEMBER 1855.*Survey.*

The clearing of the jungle has been fairly commenced at Dechouree,
 Dechouree, and the first result has been the exposure of the
 iron ore in large masses, and of good quality, immediately beyond the broad open ravine mentioned in a former Report. Mr. Commissioner Batten visited the place a few days ago and expressed his satisfaction at this new discovery. It is very close to the furnace now being built.

The clearing of the jungle has also fairly commenced at this important
 Peshpoor (Haldwa) point, which is within a short distance of the Golah
 River, and it is satisfactory to have to report that the first result of this clearing has been the exposure of the bed of iron ore on both sides of the small stream near which it is found. On the right bank the bed is seen to a considerable thickness (probably 40 feet,) but is greatly covered with detritus, which is now being removed. The specimens of ore obtained are more free from the flakes of white clay mentioned in a former Report and are of a decidedly better quality on the left bank of the stream. The ore is not exposed to a great thickness: this is in a direct line with the stroke of the bed from the former opening, and about one-quarter of a mile distant, and it clearly and distinctly shows the continuity of the bed in a longitudinal direction. The old opening now exposes the bed to a thickness of 50 feet.

Pieces of iron ore have been obtained from points further up the small ravine, but the search is now being continued on towards the Bumouree bungalow, a point on the banks of the Golah River.

Futtehpur. Several specimens of good lignite have been obtained from this place, and also a few pieces of
 Chownstila. good iron ore: it is apprehended however that the bed lies deep.

Some small specimens have been obtained from the Westward near Westward of Dechouree. Kolah, and the search is being carefully carried on in that direction.

The works at Dechouree are now being steadily proceeded with; the Dechouree experimental works foundations for the furnace have been built, and the walls are 4 feet above the foundations,

The making of the fire-bricks has been found somewhat difficult, owing to the material used being quite new to the native workmen. The first difficulty has been overcome and the work is proceeding satisfactorily. Nearly the whole of the timber has been cut and prepared for the wheel and other machinery, and the framing is now being put together.

A haccery road has been opened to Kaleedoongee at an expense of Rupees 30.

(Signed) W. SOWERBY,
Engineer in charge.

The 28th November 1855.

—
(COPY.)
No. 415 OF 1855.

FROM

J. H. BATTEN, ESQUIRE,
Commissioner, Kumaon Division.

To

W. MUIR, ESQUIRE,
Surveyor to Govt. of the N. W. Provinces.

Dated Camp Haldwanee, the 6th December 1855.

GENERAL DEPARTMENT.

SIR,

I HAVE the honor to forward Weekly Progress Report ending 1st December 1855, from Mr. W. Sowerby, Engineer in charge.

I have the honor to be, &c.,

(Signed) J. H. BATTEN,
Commissioner.

KUMAON COMMIS' S OFFICE; }
Camp Haldwanee, }
The 6th December 1855. }

—
(COPY.)

HIMALAYAN IRON WORKS, KUMAON.
WEEKLY PROGRESS REPORT, DECEMBER 1ST. 1855.
Survey.

Westward.

The Survey to the Westward has been continued during this week, and the following are the results :

The District in a line from Dechouree to Ramuuggur is a series of undulating Hills and Doons, sections of which are obtained in crossing the Dubka, Kitcheree, and Kossilla Rivers. These sections show the strata to be chiefly alternate beds of gravel, soft sand-stone, boulder beds, and a kind of hard conglomerate of lime and gravel lying nearly horizontal. There are few or no indications of iron-stone in this District, nor up the Kossilla River as far as Duckalee. To use a native phrase, the Hills are not pukka.

Duckalee to Setee. From Duckalee to Setee the indications are also very few.

Near a place called Bhora Köt up the Huttoula Nuddee, in a kind of iron ore near Bhora ferruginous killas, some few specimens of iron Köt ore have been found, and beyond Bhora Köt, a short distance to the Eastward, there are large blocks of highly ferruginous quartz rock, with a great deal of iron ore, similar to the rich ore found in the interior at Ketsaree. Some pieces are exceedingly rich and heavy, but being associated with quartz of a crystalline character, it will be very refractory in the furnace, and may become useful for mixing with the other ores. No bed has been discovered, but the indications are very favorable. There are beds of ferruginous killas in the same locality : this is between Bullona and Pat Köt.

A little to the North of Pat Köt, the geological formation is the same as at Bhora Köt, namely, a kind of ferruginous iron ore near Pat Köt killas, with small blocks and pieces of very rich iron ore, but nothing like a bed of any extent has been found in this locality.

To the South-east of Pat Köt, near the village of Ghora Köt, iron-stone of the same character as that found at Dechouree and Loha Bhur Bhur has been discovered in the sand-stone formation. In a ravine branching off from the Khuddharee Nuddee, close to Ghora Köt, the iron stone is seen in huge blocks lying on the slope of the Hill for a considerable distance, exactly the same as at Dechouree and Loha Bhur Bhur, and in as great quantity as at those places. The ore is a red and brown clay iron ore as at the two places above named. The Khuddharee Nuddee is a small tributary stream of the Kitcheree River and it is nearly dry, but at the Kitcheree River, which is about one

N.W. dies very near
the source of the Kitch-
eree River.

mile distant, it is stated by the inhabitants that there is plenty of water. This requires to be verified. There is lime-stone in the neighbourhood, and a dense forest all round, continuing from this point (Ghora Kôt) to nearly the Dubka Nuddee, a distance of $2\frac{1}{2}$ or 3 miles. The iron ore is found in blocks and masses up all the ravines and along the hill-sides. Almost every other stone is a block of iron-stone. No excavation has yet been made to expose the bed *in situ*. The Dubka is nearly dry at the point where the line crosses, but higher up and lower down there is a good supply of water. This discovery is important, being between two considerable streams, and proves the deposit to continue in a Westerly direction.

Kossilla. A research is now diligently made on the banks of the Kossilla ; information has also been received that iron ore is found in the Patlea Doon.

Patlea Doon. The jungle has been cleared in this locality and iron ore has been found on both sides of the deposit at Dechouree formerly described.

Dechouree to Bhoomka. Several very rich specimens of iron-stone have also been obtained from the point formerly mentioned up the Boer River near Bhuggur.

Bhuggur. From Futtchpoor, near Chownsilla, several very rich and heavy specimens of iron-stone have been obtained of different qualities.

Beejapoor. This locality is now being fast cleared of jungle.

Huldwanee. The works at Dechouree are being carried on as rapidly as possible.

Dechouree works. The first batch of fire-bricks has been drawn from the kiln ; as was expected, the bricks are not of the first-rate quality, but they are nevertheless a fair sample.

The furnace is built up to the arches, which are now nearly half-built. The timber for the machinery (wheel, &c.) has been nearly all cut and dressed, and the framing is being fast put together.

Tramway. The wood for a short tramway has been partly cut, and will be forthwith laid down.

(Signed) W. SOWERBY,
Engineer in charge.

The 4th December 1855.

(Copy).

HIMALAYAN IRON WORKS, KUMAUN

WEEKLY PROGRESS REPORT OF WORK DONE AT DECIDUOREE.

December, 3rd December 1855.

DATE AND MONTH.	Days of the Week.	Chapmenets Dawyers.	Stone-masons. Black-smiths.	Breck-minkers. Cooles.	REMARKS.
26th November 1855,	Monday, ...	21	8	25	2 10 183
27th Ditto,	Tuesday, ...	21	8	25	2 10 182
28th Ditto,	Wednesday, ...	21	8	25	2 10 182
29th Ditto,	Thursday, ...	21	8	36	2 10 182
30th Ditto,	Friday, ...	21	8	36	2 10 182
1st December 1855,	Saturday, ...	21	8	36	2 10 182

{ 26th November 1855, Monday, ... 21 8 25 2 10 183 The workmen and coolies employed as
27th Ditto, " Tuesday, ... 21 8 25 2 10 182 the previous week.
28th Ditto, " Wednesday, ... 21 8 25 2 10 182 The wood-work is nearly all completed;
29th Ditto, " Thursday, ... 21 8 36 2 10 182 jungle cut, and temporary roads formed.
30th Ditto, " Friday, ... 21 8 36 2 10 182 (Signed) W. S.

(Signed) REES DAVIES,

Superintendent.

(Signed) W. SOWERBY,

Engineer in charge.

The 4th December 1855.

(20)

(COPY.)

No. 425 OF 1855.

FROM

J. H. BATTEEN, ESQUIRE,
Commissioner, Kumaon Division,

To

W. MUIR, ESQUIRE,
Secy. to Govt. of the N. W. Provinces.

Dated Camp Hulduvanee, the 15th December 1855.

GENERAL DEPARTMENT.

SIR,

I HAVE the honor to forward Mr. Sowerby's Report of Weekly Progress at Dechouree, &c. I also beg to enclose a previous Report, No. 2, which by some mistake was retained in this Office.

I have the honor to be, &c.,

(Signed) J. H. BATTEEN,
Commissioner.

KUMAON COMMR'S OFFICE ; }
Camp Hulduvanee, }
The 15th December 1855. }

(Copy.)

HIMALAYAN IRON WORKS, KUMAON.

WEEKLY PROGRESS REPORT OF WORK DONE AT DECHOUTREE.

(21)

DATE.	Days of the Week.	Carpenters.	Sawyers.	Bricklayers.	Gutter-makers.	Stone-masons.	Coolies.	REMARKS.
1st Nov. 1855,	Thursday, ...	10	8	0	0	0	17	Carpenters and sawyers employed in felling trees and squaring timber for machinery and coolies in digging foundation for furnace.
2nd Ditto, ...	Friday, ...	10	8	0	0	0	17	
3rd Ditto, ...	Saturday, ...	10	8	0	0	0	17	

(Signed) REES DAVIES,

Superintendent.

The 16th November 1855.

(Signed) W. SOWERBY,

Engineer in charge.

(Copy.)

HIMALAYAN IRON WORKS, KUMAON.

WEEKLY PROGRESS REPORT OF WORK DONE AT DECHOURIE.

DATE.	Days of the Week.	REMARKS.			
		Carpenters	Sawyers	Bhikhlayers	Quarry-men
				Stone-masons	Coollies
5th Nov. 1855,	Monday,	10	8	0	0
6th Ditto,	Tuesday,	10	8	0	0
7th Ditto,	Wednesday,	10	8	0	0
8th Ditto,	Thursday,	10	8	0	0
9th Ditto,	Friday,	10	8	0	0
10th Ditto,	Saturday,	10	8	0	0

(Signed) REES DAVIES,

Superintendent.

The 16th November 1855.

(Signed) W. SOWERBY,

Engineer in charge.

(22)

Carpenters and sawyers employed in felling trees and squaring timber for machinery and coolies in digging foundation for furnace and bringing timber from jungle.

COPY.

HIMALAYAN IRON WORKS, KUMAON.

WEEKLY PROGRESS REPORT OF WORK DONE AT DEHO'REE IN NOVEMBER 1855.

DATE	Days of the Week.	Carpenters	Sawyers	Bricklayers	Stone masons	Quarry-men	Cofflers	REMARKS						
								Monday, ...	Tuesday, ...	Wednesday, ...	Thursday, ...	Friday, ...	Saturday, ...	Sunday, ...
12th Nov, ...	Monday, ...	11	8	0	0	0	46							
13th Ditto, ...	Tuesday, ...	11	8	0	0	0	56	Carpenters and sawyers employed						
14th Ditto, ...	Wednesday, ...	11	8	0	0	0	57	in felling trees and squaring timber for machinery; coadies in digging						
15th Ditto, ...	Thursday, ...	12.	8	0	0	0	60	furnace foundation, clearing stone						
16th Ditto, ...	Friday, ...	12	8	0	0	0	94	quarry, making road, and clearing						
17th Ditto, ...	Saturday, ...	12	8	0	0	0	99	away the jungle.						

REES DAVIES,
Superintendent.

(Signed)

W. SOWERBY,
Engineer in charge.

The 17th November 1855.

(Signed)

(Copy.)

HIMALAYAN IRON WORKS, KUMAON.

WEEKLY PROGRESS REPORT OF WORK DONE AT DECHOCREE.

Dechocree, 19th November 1855.

(24)

DATE	Days of the Week.	Carpenters	Wrights	Stone masons	Quarrymen	Brick-makers	Blacksmiths	Coopers	REMARKS.
19th,	Monday,	... 13	8	18	0	5	+	1	Carpenters preparing frame-work for wheel, &c. &c.
20th,	Tuesday,	... 13	8	18	0	5	4	1	Sawyers felling timber and sawing it for frame-work.
21st,	Wednesday,	... 13	8	20	0	5	2	1	Stone-masons building furnace foundation.
22nd,	Thursday,	... 13	8	20	6	5	2	1	Brick-makers making bricks and preparing brick-kiln.
23rd,	Friday,	... 13	8	20	0	5	2	1	Blacksmiths making and repairing tools, &c.
24th,	Saturday,	... 13	8	24	0	5	2	1	Coolies cutting tramway road, clearing jungle, carrying stones, &c.

(Signed) W. SOWERY.

(Signed)

REES DAVIES,

Superintendent.

Engineer in charge.

The 27th November 1855.

(COPY)

HIMALAYAN IRON WORKS, KUMAON.
WEEKLY PROGRESS REPORT OF SURVEY, &c.

The 8th December 1855.

THE iron deposit has now been successfully traced from the Dubka River up to and beyond the Kossilla River. Immediately after crossing the broad dry bed of the Dubka, a little to the North of a village called Ghutoorah, the iron bed is seen in a ravine, and from this point, in a nearly North-west direction, the bed is successively seen out-cropping in a great number of places, sometimes to a considerable extent and thickness; at other places intermediate, small blocks of it are found lying on the surface, and here and there larger blocks. Those outcrops and blocks continue up to the ravine a little to the North of the village of Umraihee (Ghora Kot) mentioned in the last week's Report, where the huge blocks are found scattered on the surface as at Loha Bhur Bhur, for a distance of half a mile, and lower down towards the river the bed *in situ* is seen exposed to a thickness of about 20 feet and upwards from Umraihee to the Bunrance Nuddee at the Eastern side of Pat Kot. It is found in various ravines and on the Hill slopes, in large and small blocks.

In the deep ravine of the Bunrance Nuddee, the bed has been cut through by the river, and is found at a considerable depth in the ravine exposed in a high precipice. It alternates, or is embedded in the sand-stone formation, dipping a little to the West of North at an angle of about 25°. Owing to the dense jungle on the steep hill-side and surface soil, the precise thickness of the bed could not be readily ascertained. The ore remains of the same character as at Loha Bhur Bhur, namely, a brown clay ore of a slight metallic lustre when fractured. When near the surface and a good deal weathered, it is poor, but the specimens found in thicker parts of the exposed bed are rich and heavy to the hand. Frequently the ore is spotted with pea-like crystals. On the gently sloping ground South of Pat Kot the bed is not seen, nor any indications, but beyond this point on the hill-sides, and in the ravines, in the same direction as before, it is found passing South of Munsainee village and again at the Kossilla River. The point on the Kossilla where it is found is about 2½ miles above Duckaleo; it is obtained on the hill-sides on both banks of the river. Mines are now being dug to ascertain precisely the true character of the deposit there. The specimens obtained from the Western

bank of the river are heavy and resembles the best quality of the Beejapoore (Huldwaneo) ore.

The point where the ore is found on the Kossilla is very convenient for the establishment of large works. Hackries go much higher up, and the quantity of water power is very considerable.

The quantity of water in the Kitcheree River is also very considerable, where works would be erected. This point is about ^{Kitcheree River} $2\frac{1}{2}$ miles from the iron bed near the Lecta Buunce temples, where two streams join to form the Kitcheree. From works established at this point, the bed of iron ore would be very easily obtained down tramways laid from the mines, at any point from Ghutoorah to opposite Pât Kôt. Lime-stone is also obtainable in abundance, especially in the ravine close to Uinharee.

The discovery of the continuity of the deposit of iron ore to the Westward may be regarded as exceedingly satisfactory, especially on the banks of the Kitcheree and the Kossilla Rivers; and although at many intermediate places, the bed has not been found cropping out, yet, wherever the contour of the Hills or the crossing of ravines has been found favorable to the exposure of the bed, there it has been found. Many of the points mentioned have only just been discovered, precise details cannot therefore be given.

Some excavations have been made at Latee Bullona, where the ferruginous quartz with iron ore has been discovered.
^{Latee Bullona.}

The specimens obtained at a short distance below the surface are of a deep crimson color, resembling cinnabar, for which it might be easily mistaken. It maintains its character of being associated with quartz and is highly refractory, but may prove useful in mixing with the very fusible ores of the newer rocks.

The intermediate points to the Kossilla from Pât Kôt are now being carefully researched and also the banks of the Raungunga.

The works at Dechouree are now making rapid progress. The arches of the furnace have been turned and the foundations for the water-wheel dug and laid.
^{Dechouree works.}

The making of fire-bricks also proceeds more satisfactorily than at first, the native workmen having become used to the material.

(Signed) W. SOWERBY,

IN CAMP ON THE KOSSILLA, }
The 13th December 1855. }

Engineer in charge.

(Corr.)

HIMALAYAN IRON WORKS, KUMAON.

WEEKLY PROGRESS REPORT OF WORK DONE AT DECHOTREE.

Dekhoree, 10th December 1855.

DATE	Days of Week.	REMARKS.									
		Carpenters.	Sawyers.	Blacksmiths.	Stone-masons.	Coolies.	Lime-burners.	Brick-makers.	Chaplers and Tailors.	Road-makers.	Trimwary.
3rd,	Monday,	21	0	2	37	136	25	36	34	16	The arches of the furnace have
4th,	Tuesday,	21	2	2	37	130	25	36	34	16	been turned. The foundations of water-
5th,	Wednesday,	21	4	2	37	130	25	36	34	16	wheel are now being cut and laid out;
6th,	Thursday,	21	4	4	37	127	25	36	34	20	the timber framing has been in great
7th,	Friday,	21	4	4	37	127	25	36	34	20	part fitted.
8th,	Saturday,	21	4	2	37	127	25	36	34	20	

(Signed) W. SOWERBY,

Engineer in charge.

(Signed) REES DAVIES,

Superintendent.

(COPY.)

HIMALAYAN IRON WORKS, KUMAON.

WEEKLY PROGRESS REPORT OF SURVEY, &c.

EMPLOYED during the greater part of the week in organizing the Works at Dechouree. works at Dechouree, also in getting the jungle cleared, setting out and forming roads to works, quarrying stone, making bricks, &c. The roads have now been all cleared, or nearly so, and the old hackery track to Kaleedoongee is being opened out. Some difficulty has been experienced in obtaining laborers of a suitable kind, owing to the work being new and the men not accustomed to it : likewise in obtaining tools, which have to be brought from a distance (Moradabad or Rampoor.) Those requirements are however being now fast supplied by the Senior Assistant Commissioner.

The clearing of the jungle has been let by contract at suitable prices, under the advice of the Senior Assistant Commissioner.

A searching party has now proceeded to the Westward, and have sent in several specimens of inferior iron ore found about 2 miles to the Westward near the village of Shaat Ghudawa.

The ground is being opened at several new places ; the results are yet unknown, except at Beejapoore, where a large opening has been made into the iron bed about six chains on the upper side of the previous opening. The details will be given next week.

A path has been cut through the jungle under the directions of Lieutenant-Colonel Drummond from the high seat at the West end of Loha Bhur Bhur towards Bhoonka, and the result has been the exposure of the bed in large masses in three different places.

In the first place it is seen close to the bed of the Kora stream to a length of 150 feet and depth of about 10 feet. A few hundred yards further on it is again seen to a length of about 150 to 200 feet and a thickness of about 10 or 12 feet. Those two places expose the bed on its longitudinal face. The bed appears undisturbed and *in situ* at a distance of about a quarter of a mile further on, and close to the Bhoonka bed the ore is again seen exposed transversely to a length of about 100 feet and to

Loha Bhur Bhur to
Bhoonka. New discovery
by Lieutenant-Colonel
Drummond.

a thickness of 20 feet (more or less,) a half dry stream passing at each side of the mass and leaving it quite exposed. No new excavations have been considered necessary here at present. The ore is a rich brown iron ore, similar to that found at Loha Bhur Bhur and of a metallic appearance when fractured. The finding out of those new beds is of very great importance, as it settles the question completely as to the character of the Loha Bhur Bhur deposits, proving their continuity beyond all doubt, and that they are not mere "pots" as has been suggested or supposed by one or two parties that have visited them.

(Signed) W. SOWERBY,
Engineer in charge.

DECHOUREE,
The 20th November 1855. }

No. 172 OF 1856.

FROM

C. P. CARMICHAEL, ESQUIRE,
Asst. Secy. to Govt. of the N. W. Provinces,

To

J. W. DALRYMPLE, ESQUIRE,
*Offy. Secy. to Govt. of India,
Home Department.*

Dated Agra, the 12th January 1856.

DEPARTMENT PUBLIC WORKS,
PUBLIC.

SIR,

In continuation of Mr. Secretary Muir's letter, No. 2658 A., dated 26th December last, I am desired by the Hon'ble the Lieutenant-Governor to forward, for the information of the Most Noble the Governor General of India in Council, the accompanying copy of a Weekly Progress Report, ending December 15th, of the survey of the iron works in Kumaon by Mr. W. Sowerby, Engineer in charge.

I have the honor to be,

SIR,

Your most obedient servant,
C. P. CARMICHAEL,
Asst. Secy. to Govt. N. W. Provinces.

AGRA,
The 12th January 1856. }

(COPY.)

HIMALAYAN IRON WORKS, KUMAON.

WEEKLY PROGRESS REPORT OF SURVEY ENDING 15TH DECEMBER 1855.

THE District from Munsainee to the banks of the Kossilla has been

Discoveries on the Kossilla River. again gone over, and the result is a most completo proof of the existence of an immenso abundance of iron-stone. The Hills called the Oookulkeo Doong Hills on their Southern slopes is literally full of iron-stone from the lowest valleys to the highest peaks. The bed *in situ* was noticed particularly in a ravine a little to the West of Choopra; also huge blocks of it in all the ravines and hill-sides, inspected right up to the Kossilla. The specimens obtained, however, is not of a very rich quality, but good useful iron-stone.

In the same Hills lime-stone has been found of a good quality.

Beyond the Kossilla, in the Dungar Nnddee, about one mile below

Beyond the Kossilla. Mohan, a bed of the same description of ore as that found at Boejapoer has been discovered. The bed is seen to a length of about 120 feet, and to a thickness of 20 feet, the floor of the bed not being seen at that depth. In the same locality, the white fire-clay has been found, and at a short distance lime-stone is found. Further up the Valley of the Kossilla, at Puneealee Ghar, a heavy kind of ore is obtained. The bed is seen to a length of 100 feet and about 3 feet in thickness. In the Valley of the Kossilla a fine kind of loam is found, very suitable for foundry purposes.

Continuing along the road towards Ghurar, on the banks of the Ramgunga,

Between the Kossilla and Ramgunga. ga, a bed of iron-stone is seen in a half dry stream : it is about 2 feet 6 inches in thickness, and is seen on both sides of the stream for a considerable distance : it is in nearly horizontal strata and is not of a rich description, being the spotted iron-stone. This is about 3 miles from the Ramgunga. In the same stream, still nearer the Raungunga, another outcrop is seen of the same kind of

Now discovery on the Ramgunga River. iron-stone. Close to the banks of the Raungunga, about 300 yards below the village of Ghurar, there is an outcrop of the poorer description of yellow hydrated iron-stone of considerable thickness, and higher up, in a dry ravine, there is a bed of a better quality, also of some extent. It is of the description with pea-like nodules in the stone.

On the East bank of the Raungunga, about one mile below the village of Ghurar, and near a ford across the river, a bed of very rich reddish

brown iron ore has just been discovered. It is similar and equal to the best description found at Loha Bhur Bhur, containing a high per-cent-age of iron. It is seen in large blocks on the hill-side for a distance measured down the slope of the Hill of 50 yards, and of considerable width, and the bed *in situ* is clearly seen, sticking up out of the surfaces. It is greatly covered with soil and detritus. The bed is also found on the opposite bank of the river, about a quarter of a mile further on; down the river the bed is again seen, but it is of a poorer quality.

Still further down the river, the white fire-clay is found, and indications of a richer description of iron ore, similar to the rich red iron ore of Dechouree. Lime-stone has not yet been discovered in this District: there are however indications of its being close at hand.

The forests in the Raungunga and the Kossilla are, if possible, denser than to the Eastwards, and the timber is chiefly saul and other hard wood suitable for charcoal.

The true character of these iron deposits having now been well ascertained, it has not yet been considered necessary to make any excavations of a great extent. A more detailed and careful survey will be made on returning Eastwards.

The lower part of the Ramgunga is now being searched, the new hickory road is already constructed up to within 2 miles of where the best iron-stone has yet been found, and access to the mine is easy.

The banks of the Ganges are now being searched, which river
The Ganges. bounds the Province to the Westward.

(Signed) W. SOWERBY,
Engineer in charge.

IN CAMP ON THE RAMGUNGA,

The 17th December 1855.

The works at Dechouree having been visted by Captain Strachey, he
Dechouree Works. will be able to report progress.

(Signed) W. SOWERBY.

No. 995 OF 1856.

FROM

WILLIAM MUIR, ESQUIRE,
Secy. to Govt. of the N. W. Provinces,

TO

C. BEADON, ESQUIRE,
Secy. to the Govt. of India,
Home Department,
 FORT WILLIAM.

Dated Agra, the 15th February 1856.

PUBLIC WORKS DEPARTMENT,
 PUBLIC.

Sir,

I AM directed to forward, for submission to the Most Noble
 the Governor General in Council.

* Letter from, No. 52, dated 2nd February
 1855, with enclosure and maps.
 Letter to, of this date, No. 994.

the accompanying copy of a cor-
 respondence* held with the Offi-
 ciating Commissioner of Kumaon, relative to Mr. Sowerby's general

Report on the iron deposits of Kumaon and Garhwal.

I have the honor to be,

Sir,

Your most obedient Servant,

W. MUIR,

Secy. to Govt., N. W. Provinces.

AGRA.

The 15th February 1856.

(COPIES.)

No. 52 OF 1856.

FROM

CAPTAIN H. RAMSAY,
Offg. Commissioner of Kumaon,

TO

WILLIAM MUIR, ESQUIRE,
Secy. to Govt. of the N. W. Provinces.

Dated Kumaon, the 2nd February 1856.

Sir,

I HAVE the honor to forward Mr. Sowerby's Report on the
 iron deposits examined by him during the course of a rapid survey of
 the lower Hills, between Chukhata and the Ganges.

(33)

2. I have received a large box of specimen of ores from Mr. Sowerby, which pending your instruction I have retained in my Office.

I have the honor to be, &c.,

(Signed) H. RAMSAY,

Offg. Commissioner.

KUMAON COMM'R'S OFFICE, 2

The 2nd February 1856. 3

GENERAL SUMMARY OF THE PRELIMINARY SURVEY OF THE
IRON DEPOSITS IN THE LOWER HILLS OF KUMAON AND
GURHWAL FROM THE GOLAH RIVER TO THE GANGES.

DESCRIPTIVE DETAILS.

The survey commenced at Beejapoor, about 2 miles to the East of Beejapoor, the Golah River, where an excavation was made into the bed of iron ore, which exposed it to a thickness of about 50 feet, the ore being a red clay iron ore rather fusible, and slightly metallic in appearance when fractured. Throughout the bed are interspersed flakes of white clay, and the under-lying strata is a bed of white fire-clay. About 400 yards beyond this opening, and in a direct line with the strike of the bed, the clearing of the jungle and under wood exposed a high scar, in which the bed of iron ore is again seen out cropping to a thickness of about 40 feet. This is on the Eastern bank of the Teera Nuddee (a small half dry stream.) The bed was covered with a great deal of surface soil, which has been partly cleared, and the specimens obtained from it are of a better quality than at the point where the opening was made, being heavier, more metallic, and more free from the flakes of white clay. The corresponding portion of the bed on the opposite side of the stream is but little exposed, being covered with huge boulders of sand-stone and surface soil. Lime-stone is obtainable within a short distance of this place. The Golah is a large stream.

At Muchear, Popul Pekree, Puncalee and Puttepoor—all in the Chownsilla, neighbourhood of Chownsilla—narrow beds of inferior siliceous looking ore were found, the beds seldom exceeding 2 or 3 feet in thickness: also beds of white clay and rich red ferruginous clay. The Hills here recede considerably to the Northward. The streams in this locality were quite dry when visited.

From further explorations at Loha Bhur Bhur, it now becomes apparent that there are two distinct beds at that place. The Western part of the iron bed is a bed of hydrated brown iron-stone, and the Eastern part, where a portion was supposed to have slipped down the Hill bodily, is in fact a lower bed of more compact brown iron-stone : the upper bed is again exposed at Derat Khera.

The intermediate space between Loha Bhur Bhur and Dechouree has been cleared of jungle, and the result has been the exposure of huge masses of rich compact brown iron-stone, and the bed *in situ* at several places to the Westward of the village of Bhoonka. The masses are seen for a distance of more than half a mile, some of these masses being many tons in weight ; they appear to be the outer edge of the bed broken up. Thence to Dechouree, a distance of about 2 miles, there is an interval where but few specimens have been obtained, and those of an inferior quality coming from narrow beds.

A shaft has been stuck at Dechouree in the broad open ravine to a depth of about 18 feet. The first 12 feet below Dechouree the surface is a very compact and rich bed of iron-stone ; afterwards the bed becomes like that at Beerpooch, with flakes of white clay interspersed, and the white clay becomes more frequent, and the ore poorer as the shaft continues downward. Above the iron bed at Dechouree are alternate beds of white sand-stone, red ferruginous clay, white fire-clay, and interpersed in the sand-stone are very thin and short scums of lignitic coal. Above the white sand-stone, high up in the Hill, a bed of compact brown iron-stone is found : it is exposed in large masses at the surface, the one is exactly similar to the bed at Loha Bhur Bhur, and still higher up in the Hill, above this bed, other beds of inferior iron-stone are found. These latter beds are narrow and are in the yellow micaceous sand-stone formation. Higher up the Boer Nuddee several ferruginous beds are found ; they are chiefly however red friable clay stones.

The specimens obtained from the Hills between the Boer Nuddee and Dechouree to the Dubka are chiefly of an inferior character, found in small blocks near the village of Shail and Gugaree. Coming from narrow beds, the Hills here retreat considerably to the Northward.

After crossing the Duhka Nuddee, near a village called Ghuttoorah, the iron-stone is seen a short distance up a half dry ravine, and from this point in a nearly North-westerly direction the bed is successively seen out-cropping, sometimes to a considerable thickness, and at other places only small blocks are seen on the surface. These out crops and blocks continue up to the ravine a little to the North of the village of Umraihoo (Umrahee, Ghora Kot.) where huge masses cover the hill-side, and near the same place in a dry ravine the bed *in situ* is seen to a thickness of about 20 feet.

From Umrahee to the Bamunee Nuddee (a tributary of the Kitchereo River, to the Bamunee River, Pat Kot) at the Eastern side of Pat Kot blocks of the iron-stone are found in the numerous ravines and on the Hill slopes; and low down in the Bamunee Nuddee a bed is cut through and is seen *in situ* in the sand-stone. Owing to the dense jungle and surface soil the precise thickness could not be ascertained. The ore along the whole of this District is of the same character as at Lohri Bhar Bhar, namely, a brown clay ore, heavy in the hand, and the fracture slightly metallic, sometimes very much so.

Lime-stone (tara) is obtainable in this locality, a wall of it was noticed in the Kuddaree Nuddee, near Umrahee.

The Duhka River, at the upper part of it, might be sufficient water power of the Duhka to drive the machinery for a couple of blast furnaces.

The quantity of water in the Kitcheree River, near the Seeta Bunnice Water power in the Kitcheree River. Temples, (where two streams meet,) would be ample all the year round to drive machinery for four blast furnaces. This point is about 2½ miles South of the iron beds.

On the gently sloping cultivated ground, South of Pat Kot, the ore is not found. The proper position of the deposit here would be considerably beneath the surface.

A little to the North of Pat Kot, at a considerable elevation, there is a kind of ferruginous killas, with occasional small blocks of rich, but very refractory iron ore, but nothing like a bed or vein was come upon.

Beyond Pat Kot Westward the Hills contain iron-stone, as indicated by blocks on the surface. This continues up to Bhora Kot.

At Lahee Buleon there was found large masses of highly ferruginous quartz, with bits of rich iron-stone, sometimes of a bright red color, resembling cinnabar, for which mineral it might easily be mistaken. The quantity obtainable is very considerable, but it would be found refractory in the blast furnace ; it may however become exceedingly useful for mixing with the more fusible ores. These masses of ferruginous quartz are found at a high elevation. Up the Kuttula Nuddee, in the same locality, there was found beds of ferruginous killas.

Continuing in a North-westerly direction, iron-stone was found in the numerous ravines and hill-sides around Choopra, Choopra. Munsainoe and Mooluguree, right up to the Kossilla River. Beds were particularly noticed in a ravine a little to the West of Choopra and at Mooluguree. The Hills called Ookulkee doong Hills, on their Southerly slopes, are literally full of iron-stone. The beds exposed belong to the upper series, and are not thick, seldom exceeding 2 feet in thickness, and the ore is not very rich, but good workable ore.

Lime-stone exists in the same locality. Beyond the Kossilla River to the West, at a distance of about half a mile from the river, and about one mile below the village of

The Kossilla District.
Rich bed near Mohan. Mohan, in the Dungar Nuddee, (a dry stream,) a bed of rich red iron-stone is seen exposed for a length of about 120 feet and thickness of about 20 feet. The ore is a rich red clay iron-stone, precisely similar to that at Dechouree, with a small portion of white clay interspersed throughout the bed as at Beej; poor.

Iron-stone was also found near Punoadh, on the Kossilla, below Mohan. There was a great deal found lying in blocks on the surface.

Punoadh.
Chookum. At Chookum, above Mohan, on the Kossilla, a narrow bed of metallic-looking iron ore was found.

Fire-clay. The white fire-clay is found in the Dungar Nuddee, near the iron bed.

Loam. Along the bed of the Kossilla River, an excellent loam, suitable for foundry purposes, was noticed.

Lime-stone, Lime-stone (tufa) was also found in the same locality.

Water power. The water power of the Kossilla is very great.

Following the road to Ghurrai (on the Ramgunga River) beds of red ferruginous clay and white clay are exposed; especially just beyond the Dungar Nuddee ; and in a half dry ravine a bed of the poorer kind of iron-stone is seen for a considerable distance : it is about 2 feet 6 inches in thickness at the outcrop, the strata being nearly horizontal : this is about 3 miles East of the Ramgunga ; and in the same stream, still nearer to the Ramgunga, other beds are seen out-cropping of the same kind of iron-stone.

Close to the village of Ghurrai, at the edge of the River Ramgunga, there is a bed of very poor yellow clay iron-stone, Ghurrai. but it appears to be of considerable thickness.

A little to the North of the village of Ghurrai, high up in a dry ravine, there is to be seen a bed of iron-stone, about 4 feet in thickness.

On the East side of the Raungunga, and near a ford in the river, Two miles below Ghurrai there is a bed of rich reddish brown iron-stone, similar to that of Loha Bhur Bhur. Large blocks are visible on the hill-side, nearly down to the water's edge, over a distance of about 200 feet, and the bed *in situ* is seen sticking up at the surface. It is greatly covered with surface soil ; the bed is also found on the opposite side of the river. About a quarter of a mile further down the road the same (or another) bed is again seen, but of rather poorer quality.

About one mile further down, in a ravine to the East of the Ramgunga, beds of white fire-clay are found ; also the Fire-clay. beds of highly ferruginous red clay, similar to the Red clay. beds overlying the iron ore at Dechourie.

Lime-stone is obtainable in this locality. From the village of Ghurrai, Lime-stone. the Ramgunga runs in a nearly North-westerly direction ; the Hill slopes and ravines on the Northern side of the river are full of iron-stone ; but on the Southern side of the river there are no indications whatever of iron-stone, from a point 5 or 6 miles below Ghurrai to opposite Boxsur (a timber-cutting station). Patteedoon.

Crossing the Ramgunga, about half a mile above Boxsur, on the Boxsur to Choulcherree. new road to Choulcherree, (a timber-cutting station,) about half a mile beyond the river and about a quarter of a mile from the village of Simulkurree, the brown iron-stone is seen in

Simulkurree.

masses on the hill-side, along which the road passes. The walls of the road are partly built of it, the distance over which the blocks are seen is considerable and appear to be lying in a line about North-west and South-east.

About 2 miles further on the same road, beyond the Hill over which it passes, in a half dry ravine to the North of the road, a bed of compact brown iron-stone is distinctly visible to a thickness of about 30 feet: the ravine in which it is found is a branch from the Pulaen, down which access to the Raungunga is easy.

Further on the same road, about one mile, blocks of brown iron-stone are visible, and were being dug up to make the new road. The bed *in situ* is exposed in an adjacent ravine.

Still further on, in the Mullance Sot, a narrow bed *in situ* is exposed, Mullance, and large masses in the bed of the river. This ravine is the route which the proposed new road from Choulcherree to Boxsur is to take for bringing down timber.

Beyond the Sunareea or Pulaen Nuddee, which passes close by Choulcherree, the surrounding Hills are full of iron-stone. A bed *in situ* was noticed in a dry ravine; it was about 3 feet in thickness, and masses on the hill-sides.

The water power in the Pulaen Nuddee would probably be sufficient for two blast furnaces, during the greater part Pulaen River. of the year.

The road from Choulcherree to Kotree, on the Sona Nuddee, takes a very circuitous route, and passes through the centre Choulcherree to Kotree. of the Patlee Doon. On this road beds of iron-stone are seen exposed *in situ* in the sand-stone formation, and masses on the surface are come upon at almost every step, the masses sometimes continuing for upwards of a mile, the ore being a good workable iron-stone, sometimes exceedingly heavy in the hand and rich: this continues quite up to the Sona Nuddee.

The Hills around Kotree are also full of iron-stone. Masses, many tons in weight, are found lying on the surface on the Kotree. hill sides and in the ravines: this is especially the case near the village of Kharce, where masses were seen lying on the surface for a length of about 200 feet and a width of 90 feet: also in the corresponding Hills, West of the Sona Nuddee, similar masses were observed.

The Sona Nuddee contains but little water at the dry season of the Sona Nuddee year, probably just sufficient to drive a small wheel Water Power. for one blast furnace.

At Kotdwara, on the Koh Nuddee, several beds of brown iron-stone are visible in the sand-stone formation, and blocks Kotdwara. of it are found lying on the hill-sides, especially at a point about a quarter of a mile above the village. On the road-side to Seerinugger, beds of white fire-clay are also seen exposed in the high banks of the river close to the village; also red ferruginous clay.

About a mile beyond Kotdwara to the Westward, up a ravine at present dry, in a high scar, a bed of compact rich brown iron-stone exists—it is about 3 feet in thickness at the outcrop, and is exposed for a distance of upwards of 150 to 200 feet. Masses of it are found lying in the bed of the stream. About 50 feet above this bed, in the same scar, there is another bed of a reddish brown iron-stone, rather poorer in quality, but good workable ore—it is about 4 feet in thickness. In the same ravine the white fire-clay and the red clay beds are also found.

Lime-stone. Lime-stone (tnfa) is obtainable at some little distance further into the Hills.

The water power of the Koh Nuddee would be ample at all times of Water power of the Koh Nuddee. the year for driving machinery for two blast furnaces, and the high banks on each side of the river are well suited for sites for the furnaces.

From Kotdwara to Lol Dâk, iron-stone, of an inferior kind, has been found in almost every ravine crossed, coming from narrow beds in the sand-stone : the whole of these ravines are dry, or nearly so.

Around Lol Dâk, beds of a good workable iron-stone were found, Lol Dâk. also red ferruginous clay beds and white fire-clay by the side of the Rowason Nuddee.

The water power of the Rowason Nuddee would probably be sufficient The water power of the Rowason. for one or two blast furnaces during a greater part of the year.

In the Mittewallee Nuddee (which is half dry) to the West of Lol Mittewallee Nuddee. Dâk, there is a bed of red clay, and beyond this the Hills appear to contain a great quantity of iron-stone, as indicated by blocks on the hill-sides and in the ravines.

The Hills to the North of the village of Mundil (6 or 7 miles from Mundil. The Ganges) were found to contain iron-stone, but chiefly of an inferior character. The ravines were full of large blocks coming from the upper narrow beds, and in a ravine about 2 miles from the Ganges, West of Mundil, blocks of iron-stone were found in abundance, not very rich, but a serviceable iron-stone. Occasional bits were very rich and heavy. Following this ravine high up in the Hill, three distinct beds were come upon of a thickness varying from 1 foot 6 inches to 2 feet 6 inches : they were exposed only for a short distance.

In this locality the white sand-stone was found ; also the red clay beds indicative of a richer description of iron ore, but no rich bed was found actually exposed.

A little above Ghorec Ghât on the Ganges, a small stream empties The Ganges. itself into the river, coming from the neighbourhood of the village of Tal. Proceeding up this stream for about 2 miles, the Hills on each side become steep and precipitous, the formation being Tal Nuddee. a compact clay-slate, in which are found beds of ferruginous killas and alum shales. In a dry ravine running up the hill-side, on the Northern bank of the stream, masses of very heavy rich red iron-stone were found for a distance of about 300 feet measured up the Hill slope. One mass amongst many was found, weighing about 200 lbs., and contained about 70 per cent. of metallic iron : it was forwarded to the Roorkee Works. This kind of iron ore is usually found in veins in the older formations, and judging from the masses on the surface, these veins must be of very considerable thickness, but owing to the immense amount of detritus on the hill-side, no veins were visible. The removal of this surface soil and detritus will be a work of considerable labour, and the subsequent mining of the ore very difficult and expensive. The ore is also refractory.

The ferruginous killas contains but a small per-cent-age of iron, and would not be worth smelting alone, but might become useful for mixing. The beds are of considerable thickness.

Several other beds of a ferruginous character were also found up this stream, but no bed of iron ore.

Lime-stone. Lime-stone in masses were also found in the same stream.

In this ravine were also found several veins of carbonaceous shale (or Carbonaceous shale in mineral block,) a portion of which was mined, and Tal Nuddee. it appeared to be continuous. It is mixed up with crystals of alum, sulphur, white pyrites, and other impurities, and is of little or trifling value. It is found in great abundance in all parts of the world. The only use made of it is the manufacture of an inferior kind of black lead, which it resembles.

Lower down the Ganges, near to Jumnea Bagh, small pieces of rich iron-stone were picked up, and the Hills on the Southern side of the stream were searched without success. There was found a bed of inferior white fire-clay, and the red ferruginous clay, but the Hills did not appear to be a character to yield iron ore.

Lower down, near to Hurdwar, the Hills contain ferruginous beds, which might be suitable for mixing with rich ores, Hurdwar. but too poor to be properly called iron-stone.

The existence of iron-stone has been ascertained in the Dehra Doon, Dehra Doon. but no portion of it was included in the present survey.

Returning to the Eastward from Kotdwara to Khalagurh, the lower Hills adjacent to the Plains were found full of iron-stone, chiefly of a good workable description; masses of it were found lying on the hill-sides and in all the ravines, more especially at a point along the road, about half a mile to Dohulcund.

Kotdwara to Khalagurh on the Ramgunga. huge blocks of heavy brown iron-stone are to be seen lying on the hill-side, the Hill being apparently a hill of iron-stone. This point is about 6 or 7 miles West of the Ramgunga. In this neighborhood there is also plenty of white fire-clay and the red ferruginous clay beds; also lime-stone.

In the neighbourhood of Khalagurh, where the Ramgunga enters the Plains, narrow beds of inferior brown iron-stone were found, the greatest thickness of any bed not exceeding 2 feet, nor does there exist any indication of better beds below the surface.

From the Ramgunga up to the village of Berana to the Eastward, the Berana. lower Hills are full of iron-stone of the inferior brown kind, as indicated by blocks of it on the surface.

Up the Berana Sot, at a distance of about 3 miles, large masses of brown iron-stone are found in the bed of the stream ; they are of good quality and apparently coming from a bed of no inconsiderable thickness. The precise position of the bed and its thickness could not be readily ascertained.

Along the road to Lal Jhung Eastward, the hill-sides and ravines were found to be full of the inferior brown iron-stone, and a short distance up the Sot, at Lal Jhung, a narrow bed was noticed, the specimens obtained from it not being rich. Here were also found white and red clay beds.

A little beyond Lal Jhung, on the hill-sides, masses of iron-stone of a good workable quality were found apparently coming from a bed of some thickness : these blocks were observed to be continuous for a distance of about 2 or 3 miles nearly up to the village of Dehla.

Up the Sot, at Dehla, a bed *in situ* was seen of about 2 feet in thickness. In a high scar on the East side of the stream, near the village, the bed is exposed for some distance, but it appears to be a good deal disturbed and broken up.

Beyond Dehla Got small blocks of common brown iron-stone were found for a distance of 2 or 3 miles towards Ramnuggur. Approaching that place the Hills become low and no indications of iron-stone were found.

The District from Ramnuggur to Dehouree is a series of low undulating hills and doons, sections of which, to a good depth and length, are seen in crossing the Kossilla, the Kitcheree and the Dubka Rivers. The sections seen are chiefly alternate strata of gravel, with rounded boulders, beds of soft red sand-stone, and a hard conglomerate of lime, gravel, and boulders ; the beds lying nearly horizontal. There are few or no indications of iron-stone in this District, nor up the Kossilla as far as Duckooloo.

GENERAL REMARKS ON THE IRON DEPOSITS.

The true character and disposition of these beds have now been pretty well ascertained ; they belong to a class of ores, General remarks. the mineralogical term for which is limonite, embracing the lower red clay ores, approaching the Character of beds. character of a hematite ; the other beds being compact brown iron ore, hydrated brown iron ore, and the upper and narrower beds being of the character of bog ores, originally formed

under water, and subsequently upheaved into their present elevated position. The ores from the upper beds are frequently cellular, and the narrower beds are chiefly formed of nodules of iron, mixed up clay a small proportion of lime and silecious matter—they also sometimes contain shall flakes of mica. The lower beds of red ore frequently are found to have flakes of the adjacent white clay interspersed through them.

The lower beds are of unexceptionable quality, containing a high percentage of metallic iron; the upper narrow beds
 Quality of beds. will be found valuable for reducing the richer beds; and what renders them more suitable for this purpose is that they contain a large proportion of lime. The red ferruginous clays will also be found valuable for mixing with the richer ores, the latter being generally too rich to be smelted alone.

The mining of the ore from the lower beds will be found exceedingly easy, being generally so near the surface and frequently quite above it. The narrow beds are in Working of the beds. a compact micaceous sand-stone, and will be rather difficult and expensive to work.

These ores are precisely similar to the valuable deposits so expensively worked in many parts of Europe and in Comparative character of the beds. the United States of America, and they are also of the same character as the ores found in the extensive mineral fields of South Africa recently investigated by myself, where they are found overlying a valuable coal deposit.

Commencing at Beejapoore to the Eastward, the lower bed of red iron General disposition of beds. ore is exposed; it is again seen at Dechourie and near Mohan on the Kossilla, beyond which point to the Westward it is nowhere seen actually exposed. The thick beds of brown iron-stone are however well developed at many points along the whole of the lower Hills. These beds of brown iron-stone are but little seen beyond Kotdwara, where they are however well developed.

From this it would appear that there had been a general upheaval of the beds by a disturbing force coming from the direction of South-east and following a North-westerly course, the disturbing force gradually becoming less powerful as it continued Westward, or what would produce nearly the same phenomena, there may be a general inclination of the country at the foot of the Hills towards the Eastward. This view is

supported by the researches of Lieutenant-Colonel Drummond to the East of the Golah, where the beds become richer, more compact and better developed than at any point to the Westward.

The accompanying longitudinal section will give a general idea of the disposition of the beds. The section is merely assumed, having no instruments to ascertain their relative elevations, and the maps of the Districts are generally very inaccurate. The beds are shown horizontal, in all likelihood they will be found to be undulating.

Section No. 2. shows the position of the beds with reference to the higher ranges. The general dip of the beds is about one point East of North, at an angle from 15° to 45° .

The supply of iron-stone along these lower ranges is so great, that it would be utterly impossible to give any approximate calculations. An idea of the size of the beds will be best formed by comparing them with the vast mountain range of which they form a part. If works are established on ever so large a scale, they would, in the course of ages, produce but a feeble impression on the beds.

The whole of the deposits are quite accessible by means of waggons; trainways would make them still more so. The only limit then to the production of iron is the supply of fuel. The forests along the whole Province are as dense as possible, in fact nearly in a state of nature which, in a nearly tropical climate, is something very great. They are uneven, except in a few places, and they extend as low down as Rammuggur on the Kossilla, Khalagurh on the Ramgunga, and below Jumna Bagh on the Ganges. The greater part of the timber is of a quality most suitable for making charcoal, much of it being salal and other hard wood. There is a good deal of timber, which is not so suitable for making charcoal, but would be of value for supplying steam power to work the blast furnaces, where water power was deficient.

The establishment of a few blast furnaces in the neighbourhood of the timber-cutting stations would use up the fuel cut from the trees, the branches being of no value as timber, but excellent for charcoal.

Taking the quantity of timber in these forests at a low calculation, and assuming that it is re-produced in ten years, the forest would supply sufficient fuel to keep

The quantity of fuel.

200 blast furnaces at work, each producing at the rate of three tons per day. The total annual supply of iron would be upwards of 2,00,000 tons, the area to supply this being taken at 100 miles in length and 10 miles in width, or 1,000 square miles.

The following list of specimens and localities will give a comprehensive idea of the number of beds and their relative value.

(Signed) W. SOWERBY,
Engineer in charge.

DECHOUREE,
The 30th January 1856. }

BHABUR IRON ORES.
LIST OF SPECIMENS, WITH REMARKS.

	No.	Locality.	REMARKS.
GODAW.	1	Beeja poor,	Heavy and rich.
	2	Ditto,	Tufaceous lime-stone.
	3	Pepul Pokree,	Workable, 2 feet bed.
	4	Muchear,	3 feet bed, clayey and poor, good for mixing.
	5	Puncabee,	Micaceous, sandy and poor.
	6	Ditto,	Bog ore, workable.
	7	Chownsilla,	Narrow bed, poor, but workable.
BORN.	8	Bho-mika,	Good ore, very serviceable.
	9	Ditto,	Poor, but serviceable.
	10	Dechourree,	Bottom of shaft 20 feet deep.
	10 A	Ditto,	12 feet below surface green clay.
	11	Ditto,	From blocks on surface very rich.
	12	Ditto,	Ditto ditto, rich.
	13	Ditto,	Ditto, calcined.
	14	Ditto,	White sand stone.
	15	Ditto,	Red ferruginous clay, useful for reducing.
	16	Ditto,	White tire-clay, requires well preparing.
	17	Ditto,	High up in the hill, good ore.
	18	Ditto,	Ditto ditto, hydrated ditto.
	19	Ditto,	Ditto, poor bog ore.
	20	Ditto,	Clayey slate, with stains of iron.
	21	Ditto,	Lime-stone from Dechourree, good.
DEEKA.	22	Shait,	Surface, specimen poor.
	23	Gingaree,	Ditto, ditto very poor.
	24	Ghutoorah,	Workable ore, very fair.
	25	Ditto,	Clayey, workable.
KIRETTE.	26	Umarilie,	Good workable ore.
	27	Ditto,	Ditto ditto.
	28	Ditto,	Ditto ditto.
	29	Ditto,	Poor, but workable.
	30	Pit Kot,	Ferruginous quartz, refractory.
	31	Ditto,	Refractory.
	32	Bhara Kot,	Ditto, { Quartz.
	33	Ditto,	Ditto, { Quartz.
KOSILLA.	34	Ghaitee Pahar,	Poor, but workable.
	35	Choopra,	Ditto, ditto ditto.
	36	Mook Ghurree,	Ditto, ditto, much on surface.
	37	Dungur Nuddee,	Heavy rich red iron ore.
	38	Ditto,	White clay interspersed.
	39	Panowd,	Poor, much on surface.
	40	Chookam,	Workable small bed.
	41	Cheopra,	Lime-stone, tufaceous.
	42	Kossilla,	Ditto ditto.
RAMGUNJA.	43	Ghurra,	4 feet bed, poor but workable.
	44	Ramgunga,	Small bed, poor.
	45	Ditto,	Ditto ditto.
	46	Ditto,	Below Ghurra good workable ore.
	47	Ditto,	Lime-stone tufaceous — M. Ghurra.
	48	Boxsur,	Fair, workable, much on surface.

	No.	Locality.	REMARKS.
RANGUNGA.	49	Patlee Doon,	Workable,
	50	Ditto,	Poor, workable,
	51	Ditto,	Very ditto,
	52	Ditto,	Poor, workable,
	53	Ditto,	Ditto ditto,
	54	Ditto,	Ditto ditto,
PALLEN.	55	Choulcherree,	A kind of bog ore, poor.
	56	Ditto,	Heavy, rich.
SONA.	57	Karee,	Much on surface, good, workable.
	58	Ditto,	Ditto heavy, workable
	59	Kotree,	Refractory, but workable.
	60	Ditto,	Workable.
KOM.	61	Koldwara,	Very serviceable iron-stone.
	62	Koldwara,	Very excellent, serviceable ore.
Rowman Kot.	63	Ditto,	White fire-clay, good.
	64	Ditto,	Workable, but poor.
	65	Lol Dâk,	3 feet bed, poor.
	66	Ditto,	2 feet ditto, ditto.
	67	Ditto,	Ditto ditto,
	68	Ditto,	Poor, 2 feet 6 inches.
GANGES.	69	Mundil,	Poor, small bed, contains lime.
	70	Ditto,	Ditto ditto ditto.
	71	Jumneea Bagh,	A kind of bog ore, rich specimen.
	72	Ditto,	Heavy and rich, but refractory.
	73	Ditto,	Ditto, but not rich.
	74	Tal Nuddee,	Poor and refractory.
	75	Ditto,	Ditto ditto.
	76	Ditto,	Rich, heavy and refractory, broken from the large mass sent to Roorkee.
	77	Ditto,	Rich, but refractory.
	78	Ditto,	Killas poor.
RANGUNGA.	79	Ditto,	Carbonaceous shale impure.
	80	Ditto,	Ditto very impure.
	81	Ditto,	Lime-stone tufaceous.
	82	Koldwara,	Lignite coal.
	83	Dohulcund,	Good workable ore.
DECHOURREE,	84	Ditto,	Workable ore.
	85	Khalagurh,	Poor.
	86	Lol Jhung,	Workable iron-stone.
	87	Dehla,	Ditto ditto.

(Signed) W. SOWERBY,

Engineer in charge.

The 30th January 1856. }

No. 994 OF 1856.

FROM

WILLIAM MUIR, ESQUIRE,
Secy. to Govt. of the N. W. Provinces,

TO

CAPTAIN H. RAMSAY,
Offg. Commissioner of Kumaon.

Dated Agra, the 15th February 1856.

PUBLIC WORKS DEPARTMENT.

SIR,

I HAVE the honor to acknowledge the receipt of your letter, dated the 2nd instant, No. 2, submitting Mr. Sowerby's general summary of the preliminary survey of the iron deposits in the lower Hills of Kumaon and Gurhwal, from the Golah River to the Ganges, and stating that you have received, and retained in your Office, a box of specimen ores from that gentleman.

2. In reply I am directed to intimate that the Lieutenant-Governor will have pleasure in submitting this satisfactory General Report for the perusal of the Supreme Government.

3. You are requested to take early measures for forwarding the box of specimen ores by bullock train from the nearest convenient point to Calcutta, to the address of the Secretary to the Government of India in the Home Department. The words "Specimen Ores from the Bhawar Iron Field from Mr. Sowerby," should be carefully cut, or printed, on the upper cover of the box, and you will have the goodness to send direct advice of the date of despatch of the box by the bullock train to the Under-Secretary in the Home Department.

I have the honor to be, &c.,

(Signed) W. MUIR,
Secy. to Govt., N. W. P.

AGRA, }
The 15th February 1856. }

No. 1132 OF 1856.

FROM

WILLIAM MUIR, ESQUIRE,
Secy. to Govt. of the N. W. Provinces,

To

THE SECY. TO THE GOVT. OF INDIA,
Home Department,
 FORT WILLIAM.

Dated Agra, the 20th February 1856.

PUBLIC WORKS DEPARTMENT.

SIR,

In continuation of my letter No. 995, dated 15th instant, transmitting Mr. Sowerby's General Report on the iron deposits of Kumaon and Gurhwal, I am directed to forward, for submission to the Most Noble the Governor General in Council, the accompanying copy of an Appendix to that Report since received.

I have the honor to be,

Sir,

Your most obedient servant,

W. MUIR,
Secy to Govt. N. W. P.

AGRA,
 The 20th February 1856. }

IN LETTER NO. 1132 OF 1856.

(COPY.)

APPENDIX TO THE GENERAL SUMMARY OF THE SURVEY OF THE IRON DEPOSITS IN THE BHARUR OR LOWER HILLS OF KUMAON AND GURHWAL.

Explanatory Notes to Section No. 1.

THE beds appear to alternate in the following order, with but little variation, throughout the entire range. Some minute divisions are necessarily omitted.

Disposition of the beds. Lowest beds seen.

1st. White fire-clay.

2nd. Red clay iron ore.

3rd. White sand-stone.

4th. White fire-clay (inferior.)

- 5th. Red ferruginous clay.
- 6th. White sand-stone, with thin seams of lignitic coal.
- 7th. Compact brown iron ore.
- 8th. Yellow micaceous sand-stone.
- 9th. Hydrated brown iron-stone.
- 10th. Sand-stone.
- 11th. Inferior hydrated sandy iron-stone.
- 12th. Sand-stone.
- 13th. Bog iron-stone (upheaved.)
- 14th. Sand-stone.
- 15th. Very poor boggy iron-stone.
- 16th. Sand-stone.
- 17th. Ferruginous sandy narrow seams.
- 18th. Sand-stone, with occasional bit of lignite.

The richer beds being the lowest are found close to the Plains, where the hills recede to the North for any considerable distance. The lower beds are not exposed, or may have been so, and subsequently denuded ; this is especially the case in the valleys of the larger streams and the nearly horizontal beds of soft red sand-stone ; gravel boulder beds and conglomerate are found running a long way up the valleys to the foot of the higher Hills.

Between Kotlwara and Ramnuggur, there is a sub-range of Hills, the lowest beds exposed being the red and white clays and white sandstones. This sub-range of Hills resembles in every respect the Upper Bhabur range in its formation, and requires no separate section to illustrate it.

Notes on Section No. 2.

This section gives a general idea of the position of the iron deposits with reference to the higher Hills. It is assumed as being a section from the Ganges range to the Plains, being the point where the whole of the beds are well developed.

The lower Hills appear to have been formed by a succession of deposits and upheavals, the greatest upheaval being at their outer edge, near the Plains, where the upbearing force would naturally meet with the least amount of mechanical resistance, and they have therefore a uniform dip towards the Hills, giving the beds the appearance of underlying the older rocks of the higher ranges, whereas they overlie them.

The precise geological period to which the Hills belong, in the absence of any fossil remains, it is not pretended to determine. This is however a matter of secondary importance in a practical point of view.

A more minute examination of these Hills might in all probability modify this section in many respects.

(Signed) W. SOWERBY,
Civil Engineer in charge.

DECHOURREE,
The 2nd February 1856. }

, (COPY.)

No. 10.

HIMALAYAN IRON WORKS, KUMAON.

WEEKLY PROGRESS REPORT OF SURVEY, &c., FOR THE WEEK ENDING 12TH JANUARY 1856.

In searching for iron-stone in the immediate neighbourhood of Khalagurh, the only kind found are narrow beds of a poor description in the sand-stone formation. The greatest thickness of any bed seen is not more than 2 feet.

From Khalagurh to Berana, the hill-sides and ravines are full of iron-stone of the inferior brown kind, as indicated by blocks of it found on the surface.

Following up the Berana Sot for a distance of about 3 miles, there is, in a branch ravine, called the Peepul Sot, large masses of brown iron-stone of a good useful kind.

Berana Sot. They are found in the ravine and on the slope of the Hill, for a short distance, coming apparently from a bed of no inconsiderable thickness. The precise position and thickness of the bed was not however very distinctly visible.

Along the road to Lal Jhung, specimens were obtained, and a bed of the same kind of ore was found in the sand-stone, Berana to Lal Jhung. a little way up the Sot at Lal Jhung. The thickness of the bed did not appear to be more than 6 inches at the out-crop, and the specimens obtained were not rich.

A little distance beyond Lal Jhung masses of iron-stone of a good Lal Jhung to Dehra workable quality were found apparently coming Sot. from a bed close at hand, and of some thickness :

these blocks were observed to be continuous nearly up to the village of Dehla, a distance of about 3 miles.

Up the Dehla Sot, a bed *in situ* was noticed of about 2 feet in thickness, situate in a high scarp on the East side of the Dehla Sot.

Nuddee, and a very short distance from the village [there is a small supply of water only in this Nuddee] the bed was seen for some distance, probably 100 feet, but it appeared to be a good deal disturbed and broken up.

Beyond Dehla Sot towards Ramnuggur, small blocks of common brown iron-stone were noticed for a distance of 2 Dehla to Ramnugger. or 3 miles. Approaching Ramnuggur the Hills become low and kutcha, and no indications of iron-stone were found in them. The preliminary survey to the Westward has now been so far made as to prove the existence of a large supply of workable iron-stone through the entire distance examined, embracing an area of about 1,000 square miles. More detailed information is still considered requisite, and the necessary arrangements have been made for procuring it.

Attention will now also be forthwith directed to the examination of Eastward of Dechouree the country to the Eastward in the direction of ree. Burmdeo, already explored by Lieutenant-Colonel Drummond.

The clearing of the jungle in the neighbourhood of Dechouree and Cleaning of jungle at Loha Bhur Bhur has exposed to a still further Dechouree, &c. extent the iron deposits. After leaving Dechouree to the Eastward, there is an interval of probably 2 miles, where the iron-stone is less frequently seen, and the specimens obtained are poor; but beyond this to the Eastward, huge masses, many tons in weight, are again seen exposed on the hill-side, for a considerable distance; the ore being of a heavy rich description of brown iron ore. These masses are seen continuous nearly up to the village of Bhoomka, where the existence of iron-stone has been mentioned in a former Report. The true character of those deposits having now been well and clearly ascertained, and the almost certain probability of finding the ore all along the lower Hills renders the further clearing of the jungle for the mere purpose of searching no longer necessary. The clearing of the jungle above Dechouree, on the opposite side of the river, has exposed a wall of limestone [tufa] of considerable extent. A shaft is now being sunk at De-

chouree to ascertain exactly to what depth the bed of iron-stone goes and what underlies it.

The smelting furnace is now built up to the top, and the lining with fire-bricks is nearly complete. The length of time Dechouree experimen-
tal works. absolutely necessary for preparing and burning fire-bricks has been found so great, that the smelter, Mr. Davies, has in his anxiety to get the work completed used unburnt fire-bricks, which will have to be burnt in their place inside the furnace. This is a somewhat uncertain experiment, and may lead to a failure, unless very great care is taken. It however shows the absolute necessity for making early preparations this year for the intended operations of next working season, otherwise there is likely to result only a succession of failures.

Water-wheel.

The water-wheel is far advanced, but is not yet fixed in its place.

Charcoal.

A stock of charcoal is now being prepared.

Bundling the river and forming reservoirs. The necessity for bundling the river, and forming reservoirs, has been carefully considered, and there appears to be several places where large reservoirs might be formed, the soil being, it is thought, sufficiently retentive, and would doubtless become more so every year. The present furnace is not however placed in such a position as to derive any advantage from these reservoirs if formed. The flow of water in the river still continues ample, and appears likely to remain so, as there has been no rain to keep up the flow of water, and it has not decreased. Attention will be immediately directed to form a temporary bund at the head of the channel, which has to supply the water-wheel. The plan recommended by Lieutenant Greathed, of the Engineers, is not believed to be the best, and is unsuitable, except for very temporary works.

The tramway.

The proposed short tramway has been curtailed at the suggestion of Captain R. Strachey, of the Engineers.

(Signed) W. SOWERBY,
Civil Engineer in charge.

DECHOUREE,
The 15th January 1856. }

No. 679 OF 1856.

DEPARTMENT OF PUBLIC WORKS,
PUBLIC.

ORDER.—Ordered that a copy of the above be forwarded to the Secretary to the Government of India, Home Department, for information.

C. P. CARMICHAEL,

Asst. Secy. to Govt., N. W. P.

AGRA,

The 1st February 1856. }

No. 1552 OF 1856.

FROM

MAJOR G. W. WILLIAMS,

Offy. Assist. Secy. to Govt., N. W. P., Agra.

TO

CECIL BEADON, ESQUIRE,

*Secy. to the Govt. of India,**Home Department.*

Dated Agra, the 7th March, 1856.

DEPARTMENT OF PUBLIC WORKS,

GENERAL.

SIR,

IN continuation of my letter No. 1132, dated the 20th ultimo, I am desired to forward, for the information of the Most Noble the Governor General in Council, the accompanying copy of a letter from the Officiating Commissioner of Kumaon, No. 78, dated the 22nd ultimo, forwarding Mr. Sowerby's Report on the iron works in Kumaon for the week ending February 9th.

I have the honor to be,

SIR,

Your most obedient servant,

G. W. WILLIAMS, Major,

Offy. Asst. Secy. to Govt., N. W. P.

AGRA,

The 7th March 1856. }

(COPIES.)

No. 78 OF 1856.

FROM

THE OFFICIATING COMMISSIONER OF KUMAON,

TO

THE SECY. TO THE GOVT. OF THE N. W. P.,

*Agra.**Dated Kumaon, the 22nd February 1856.*DEPARTMENT OF PUBLIC WORKS,
GENERAL.

SIR,

I HAVE the honor to forward Mr. Sowerby's Weekly Progress Report ending 9th instant.

I have, &c.,

(Signed) H. RAMSAY,
*Officiating Commissioner.*KUMAON;
Commissioner's Office, }
The 22nd February 1856.

No. 14.

HIMALAYAN IRON WORKS, KUMAON.

WEEKLY PROGRESS REPORT FOR THE WEEK ENDING 9TH FEBRUARY 1856.

THE work about the water-wheel is now nearly completed; the blast pipes, which are of wood, have been made, Dechouree works. and are ready for fixing. The blowing cylinders, also of wood, are now being fixed in their place.

The charcoal-burning for the present experiment will be terminated in the course of another week, when sufficient charcoal will have been prepared.

The bunding up of the river is now complete, so as to bring the whole of the water in the river down the old The bund. water-course, which has been put in a state of repairs so far as it is practicable.

The two mines at Dechouree, namely, a shaft and drift, have been continued, the former to a depth of 25 feet and the latter to a length of 23 feet. The object of the

The mines at Dechou-

ree.

shaft is to ascertain whether coal exists below the beds of iron ore. The drift is intimated to ascertain the distance the lower bed of iron ore continues into the Hill.

Openings into the ground to the Westward were directed to be made by an experienced native miner, and the result is Survey Westward. that at Berana the bed appears to be about 4 feet thick. At Dohulcund it is ascertained to be 10 feet thick and very good workable ore. At Kotdwara the lower bed of rich iron ore has been come upon; it is of very good quality, similar to the beds at Beeja-poor, Dechouree and Dungar Nuddeo on the Kossilla; it is about 10 or 12 feet thick at the outcrop. This latter discovery is important, as it confirms the opinion expressed in the general Report, as to the existence of the lower beds further to the Westward than had at that time been actually ascertained.

(Signed) W. SOWERBY,
Civil Engineer in charge.

DECHOUREE,
The 12th February 1856. }

REPORT,

BY MR. BARRATT,

OF THE SURVEY OF THE

MINERAL DEPOSITS IN KUMAON.

No. 2030 of 1856.

No. 19.

FROM

W. MUIR, ESQUIRE,

Secy. to Govt., N. W. Provinces,

To

CECIL BEADON, ESQUIRE,

*Secy. to the Govt. of India,**Home Department.**Dated Agra, the 29th March 1856.*

PUBLIC WORKS DEPARTMENT.

Sir,

I AM desired by His Honor the Lieutenant-Governor to transmit a copy of the papers noted in the margin, relating to the metalliferous deposits in Kumaon, and to recommend for the consideration of the Right Honble the Governor General in Council, that the Report be printed for general information.

Letter from Commissioner, Kumaon, No. 90, dated 29th February 1856, with enclosures.

2. The Lieutenant-Governor is well satisfied with the manner in which Messrs. Barratt and Gray have conducted these inquiries. But he does not think it necessary that Officers of their class should be retained in Kumaon, with a view only to the assistance or instruction of the Native miners, who are men without capital or enterprise. The employment of Messrs. Barratt and Gray need not, therefore, be continued under the Government of the North-Western Provinces.

I have the honor to be, &c.,

(Signed) W. MUIR,

Secy. to Govt. N. W. Provinces.

AGRA.

The 29th March 1856. }

(COPY.)

No. 90.

No. 20.

From

CAPTAIN H. RAMSAY,
Commissioner, Kumaon Division,

To

W. MUIR, ESQUIRE,
Secy. to Govt., N. W. Provinces.

PUBLIC WORKS DEPARTMENT.

Sir,

HIS Honor the Lieutenant-Governor is already aware, I believe, that Mr. Barratt was instructed by my predecessor to examine several mines in Kumaon and Gurhwal, which had not been visited by Mr. Henwood. I have now the honor to forward Mr. Barratt's Report which gives a clear and business-like description of all the mines he visited in company with Mr. Gray, also a list of mineral specimens collected from the various mines examined.

2. I beg to enclose detailed accounts of expenses incurred by the

* For October 1855 300 15 4
 " November 1855 249 15 0
 " December 1855 129 4 7
 " January 1856 284 14 4
 " February 1856 215 12 1
 R. 1,476 13 4

Assistant Mineral Surveyor and his party, in carrying out the investigations ordered by Mr. Batten, and I request the favor of your procuring the Lieutenant-Governor's sanction to the disbursement of Rupees 1,476-13-4.*

3. The iron mines described in the Report are worthless from their position, as they are all situated at a great distance from the plains, and iron ore deposits of equal, if not of superior quality, are abundant much nearer to the plains; but Colonel Drummond's discovery of iron on the outer ranges renders all such deposits in the interior of the hills comparatively valueless.

Mr. Barratt's Report on copper is very encouraging, but I do not recommend any attempt being made to improve the present mines for the benefit of Native lessees. The increase of Revenue on opening the mines, anticipated by Mr. Barratt, is too trifling to be thought of for a moment, and there is no *necessity* for increasing the supply of copper in the Province; the only object that could be gained would be a handsome remuneration to the first lessee.

It appears from Mr. Barratt's Report that the lead mines would be productive, if worked on a large scale, but if lead was produced in abundance, the price would fall far below the value specified in this Report. The localities where the best specimens were found are ten marches from the plains, and this would be a serious objection to having extensive works at either place, however rich the deposits may be.

In conclusion, I solicit instructions regarding the future employment of Messrs. Barratt and Gray. Their services cannot be made use of at Dechowree, as they are not, I believe, acquainted with smelting, and miners are not required there. If they can be made useful in any other district, they are now available; if there is no further occasion for their services, they had better be sent back to England at once.

I have the honor to be, &c.,
 (Signed) H. RAMSAY,
Commissioner.

KUMAON COMM'S OFFICE. }
 The 29th Feb. 1856. }

N. B.—If the specimens are required they can be sent to Agra at once.

(COPY.)

No. 21.

From

JAMES BARRATT, Esquire,
Assistant Mineral Surveyor,

To

CAPTAIN H. RAMSAY,
Commissioner, Kumaon.

Hamilton, 20th February 1856.

SIR,

I beg to hand you a Report of my examinations in a recent tour through portions of metalliferous districts in Kumaon and Garhwal, which I hope will meet your approbation. J. H. Batten, Esq., late Commissioner, previous to my departure for Garhwal, mentioned about visiting and examining the Mussoorie lead mines, also some lead mines up the Aluknanda River, on the Badrinath Road; the names I have forgotten, but know a person who has seen them. I recommend a small trial on the back of Jak lead lode; and Mr. Gray, if you approve of it,

could remain there, while myself, accompanied by Mr. Charles Thomas, the Interpreter, could be examining elsewhere, where you may be pleased to appoint. Since our departure from Jâk, Note Singh has discovered a large lode at Usheer, and from the specimens presented, it contains a great portion of sulphur. Waiting orders.

I have, &c.,

(Signed) JAMES BARRATT,

Assistant Mineral Surveyor.

No. 22.

(Copy.)

To

CAPTAIN H. RAMSAY,
Commissioner, Kumaon.

Almora, 20th February 1856.

SIR,

HAVING been directed by John H. Batten, Esquire, late Commissioner, to investigate portions of metalliferous districts in Kumaon and Gurhwal, I beg, in conformity with my instructions after a tour unaccompanied by Mr. Thomas Gray, (Miner,) and Mr. Charles Thomas, (Interpreter,) to hand you a Report of my examinations.

First.—New Copper Mines examined are Pepulee, Pringlapanni, and Murbuggetee.

No. 1. Pepulee Copper.—My attention was drawn to a place, about half a mile North-West of Pepulee village, by a Native who discovered some beautiful specimens of yellow copper ore (copper pyrites) which evidently were brought down by a land-slip from near the summit of the mountain. He informed me, the people of the place have, in and after the wet season, collected several baskets of rich copper ore, and carried them to Dobree to be smelted. If this place was well explored, the main lode would be met with above the slip in the mountain; the ore is very rich and encased in a very congenial stratum (white clay slate). No mine was ever worked that I could see on the spot, where the specimens were found and the stratum very much broken and displaced. I explored the Gutgwar Gleu where the rock was divided, but could not find the lode, probably it would take several days to discover it, which was more time than I could fitly devote to that purpose, in the present examination; however, if at any time, any European should be stationed in this mining locality, or at another convenient season, I should recon-

mend to examine the mountain where probably a good lode might be discovered. If any thing could be discovered here, there is a fine stream of water sufficient for stamping, dressing, and all other mining purposes. The Natives never remembered any mine here (only surface-digging in the land-slip,) but, about three miles West, in a line with the bearing of the stratum on the South side of the Butchingurd River, there is an old copper mine (not in operation) worked last by the Rajahs, just under the Butchingurd village. There are several old mines in this district, (Dewulgurh,) but no copper mines are in operation. Very little expense would open some of them and would be good for the improvement of the poor race of people who occupy this district, and who are desirous to get employment. If Government feels disposed to open them, probably, after a few years, would receive a good interest for the capital laid out, (good mines idle are good-for-nothing).

No. 2. Pringlapanji Copper Mine is situated about a mile North of Biergunga Bridge, on the western bank of the Ahikundu River, in Mullah Nagpore. The lode which is very wide, bears N. N. E. and S. S. W. and dip an angle of 45° W. N. W.; is chiefly composed of quartz and a little copper pyrites, mixed with black oxide of copper and iron pyrites, the quartz much tinted with the green carbonate of copper. It is not very rich nor very promising from present appearances, but if wrought to a greater extent, probably, would prove a remunerative mine. Very little has been done towards exploring it. The lode is embedded in a bluish clay slate. Wood is not abundant, sufficient only for Native smelting.

No. 3. Murbuggetee Copper Lode.—This metalliferous formation is situated about a quarter of a mile North-East from Murbuggetee village, and about two miles up the Nundaknee or Nundgunga River from Nundprag, in Puttee Bahisee, (petgumah Desolee). The lode, which is about 8 feet wide, is chiefly composed of quartz, a little clay slate, and yellow copper ore, (copper pyrites,) and thickly impregnated throughout with the green carbonate of copper. Its bearing is W. N. W. and E. S. E. and dip at an angle of 50° N. N. E., and bears through a whitish clay slate. Nothing has been done on it. It is a large promising lode, and would, from appearances, if explored, prove productive. It is quite accessible, the back or out-crop being divided and exposed by a rivulet. The mountains, on both sides, rise almost perpendicular; and a drift commenced in the out-crop would soon leave high-dry, and probably

valuable mining ground. Water is abundant, and woods on the mountains afford inexhaustible supplies for fuel and timber, both of oak and pine, for all mining requisites.

Second.—Old Copper Mines examined are Kerraye, Belar, Raie, Seera, Tomacotee, Dolree, and Dhunpore.

No. 4. *Kerraye Copper Mine* is situated at Ujolee, in Puttee Kerraye, (peygannah Chowgunkhada) The mining operations are at present confined to driving of a level or gallery on the course of the lode which bears S. E. and N. W. and dips at an angle of 30° S. W. It appears the lode, or its metalliferous course, is very wide of talc-quartz, thin layers of limestone and a little iron in the talc. Small lines or veins of yellow and purple copper ore are met with; the quartz is also slightly impregnated with copper ore and coated with the green carbonate of copper. It is generally very poor. A great quantity of the talc or metalliferous talcose matter must be raised, washed, and dressed, to obtain a small quantity of copper ore. Seven men are employed in the mine, and women at surface, who cleanse and prepare the ore for the smelter. This mine is not very rich although the lode is very wide and very easily wrought; the ore is so thinly deposited in it and so much required to be cleaned for so small a quantity of copper, that it is only the Natives who work so very cheap, can realize a sum re living by it. Wood and water, for all requisite mining purposes, can be obtained immediately on the mine.

No. 5. *Belar Copper Mine* in Congedee is situated close by the village of the same name. Considerable old workings are traced in a North and South direction, all of which are choked; the lode bears about North and South. It is a talcose coarse, mixed with quartz, thinly impregnated with yellow and purple copper ore, with occasional streaks of the black oxide of Manganese. All mining operations have been suspended for some time, the mine fallen in and abandoned. There is nothing here to be seen externally that will warrant any outlay on it, the Natives inform me it was very poor and the cause of its abandonment. Wood can be plentifully obtained on and near the mine, but no water for mining purposes in the vicinity.

No. 6. *Raie Copper Mine* in Congedee is at present choked, ruined, abandoned, and grown over with brushwood. Nothing at present can be seen within it, but considerable old workings have been made and formerly it yielded great quantities of copper ore, and from neglect in keeping it, has fallen in. I was informed by the Natives that there was

a good lode of ore in it when it was suspended in the virgin or unwrought ground. It cannot be worked properly without putting in a deep adit or gallery, which is a matter of consideration ; the expense would be enormous and probably would require more money than could be realized for a considerable time after it was re-opened. Looking at the dilapidated and ruinous state of the mine, generally, in my opinion it does not hold out sufficient inducement for the expense of re-opening. The ore is copper pyrites, thinly deposited in quartz and talc slate, in beds of limestone, with occasional layers of clay-slate.

No. 7. Seera Copper Mine is situated close by Agur village. The deep adit or mean gallery is commenced in the side of the mountain and extended in a southerly direction for about 60 fathoms, cutting the stratum and metalliferous veins at right angles, several of which were met with, and extensive workings have been made on them. The mean and most productive lode is at the end of the gallery, but for want of air the miners were obliged to abandon it in about 45 fathoms from the entrance ; the timber which was put to secure the lode, had crushed, which prevented me from examining the end or most productive workings. Mining operations are now confined to the clearing of a shallow adit or gallery, about six fathoms above the mean, but no minerals of any kind have yet been found. The mineral, from the mean workings, is yellow copper ore, mixed with iron pyrites, generally found deposited in quartz and talc, the stratum is a limestone. This mine, like many others, is falling into ruin for the want of more commodious galleries to facilitate the operations and a better system of ventilation. In order to make it a good mine, or to work it in a mining-like manner, a deep adit should be commenced, to come in about 10 fathoms under the present deep adit, which should be communicated with each other, at convenient distances. To give the required ventilation, this would require a level, 100 fathoms in length, which must be driven through a hard limestone rock and probably require more money than the mine is worth, although there is a great quantity of ore in the inner workings, by Native information, it must, from the decay of the securing, bad ventilation, &c., soon fall into ruin and be abandoned.

No. 8. Tomacotee Copper Mine is situated at Agur, on the western side of the Rani Gunga, about three miles N. N. W. from Lohba. It has two entrances up about 20 fathoms perpendicular from the base of the mountain. The mean entrance, through which the ore is extracted, is some

intersect the lode, nine hundred (900) Rupees. This being done, the mine will be thoroughly ventilated, would serve also for drainage, and the more expeditious removal of all ores, leads, &c.; and the lessee would certainly be in a position to pay double the amount of rent than he at present pays. One good thing in this mining district is, the miners are accustomed to work by night, as well as by day, consequently any portion of mining can be more expeditiously done there than in many other mining localities. There are several old mines there, and the greater part of them, I have been informed, are not abandoned through poverty only, but for the want of ventilation and a better system of mining. The stratum is generally a limestone, but, where the best deposits of ore are met with, a little clay-slate is met with on both sides of the lode. I perceive a great loss in the Native process of smelting, although the ore yield 8 or 9 per cent., they do not extract more than from 3 to 4. When I was there 50 seers of mineral were employed or smelted, it produced 5 seers, or 10 lbs., of regal (coarse copper from first process of smelting) which gives about one third fine copper, equal to 3½ lbs. or 3½ per cent., showing a great loss. Copper sells well there, two (2) Rupees per seer, equal to £22*1* per ton, which shows the value of copper mines in the Hindustan.

No. 10. *Dhanpore Copper Mine* is situated about a quarter of a mile West of Dhanpore village, on the summit, or nearly off the mountain. The copper lode, or metasomatic formation, is a great many fathoms wide, bears about East and West, is chiefly composed of quartz and limestone, the quartz thickly impregnated with the green carbonate of copper, and occasional deposits of copper pyrites, mixed with purple and vitreous copper ore of very good quality. In the present drift, or the one which yields the best ore, the branch (small vein) is about four inches wide, of vitreous copper ore, of about 10 per cent. In this drift very little is doing on account of the rocks being very hard, the miners, not yet knowing the process of blasting, after digging forth the copper vein, burn the rock to soften it, then they cut it away with chisels. Many other parts of the mine are worked for the carbonates which are profitably smelted. It contains a great quantity of ore, but not so rich as formerly, however copper lodes fluctuate, probably it may be soon rich again; large lodes make large deposits, and again dwindle and close almost to nothing; it appears these rich deposits here are met with when the cross branches intersect the East and West veins at the junctions. Twenty-five men are employ-

ed in this mine, and two furnaces are in continual operation, three more are to be put in operation immediately, with an additional number of miners. Here 100 lbs. of ore gave 8 lbs. of regal, which makes the yield of copper $2\frac{1}{3}$ per cent. this was from the inferior ore, the carbonated quartz; some other ore has been smelted which yielded 5 per cent., this was a mixture of both ores. I am pretty sure the copper of this mine is argentiferous, and would recommend analysis to be made to ascertain the proportion contained in a ton, probably it is rich enough to pay the expenses of separation and leave profit. The system of mining here appears pretty good as regards ventilation, they have one level above the other, with frequent communications, which keep the mine well ventilated. I strongly recommend to introduce blasting. If once the miners know it, they will appreciate it; they would be able to carry more commodious galleries; and both Government and them would ultimately receive the benefit of it, so much more work would be accomplished, in much less time, which would cover the expense a hundred-fold, and would be found much more profitable than the slow budgy system now in practice. The copper mines recommended to be opened are Tomaco-tee and Dobree. If Government feel disposed to open them, would doubtless, ultimately be handsomely repaid for the outlay. I am not of opinion that Government could realize much money for a few years, but after the mines are opened, the lessees would be in a position to pay considerable more dues or rent, and it would be opening the way for private capital, which if invested in Dhamapore and Dobree districts, and judiciously carried out, could not, in my opinion, fail to become very remunerative. There are very rich deposits of copper ore in those mines, and if the explorations and workings were carried on in a large scale, and on the English system of mining, considerable quantities of copper could be extracted. The mountains between Dhamapore and Dobree and Dewalgurh on the same lode or coarse, if explored, would be found to yield abundance of mineral. Several of the minor mines, though not very urgently recommended, which have very little done to prove their value, may, if opened, prove equally valuable, as those that are found rich are by being more extensively wrought. At Dhamapore the best, and by far the richest, part of the mine is most completely suspended, because the rock is hard, and ore of 40 per cent. remains worthless in the ground because it cannot be extracted by the Native system of mining, and at the same time the miners are extracting and smelting ore of 3 per cent.,

when if they knew the process of blasting, it could be very easily taken away, or extracted, without any difficulty whatever, and turned at once to profitable account. In all the mines blasting is indispensably necessary, should be introduced, and the old system of burning and chiseling be dispensed with.

Third.—New Iron Mines visited are Badersaic, Bomaotha Cherry Khan, Hartjasal, Harthakhan and Bejouragurd.

No. 11. *Badersaic Iron Mine* is situated about a quarter of a mile West of Dhunpore Copper Mine. Several old pits are sealed in and grown over with brushwood. In digging in some of them, discovered some beautiful specimens of red oxide of iron and red hematite of 70 per cent. metal. It appears to have slidden down from the North side of Dhunpore great metalliferous formation. Any quantity of very rich iron ore can be obtained already broken and lying on the surface (no one remembered it in operation.) The lessee of Dhunpore and Dobree copper mines is desirous to obtain a lease to work this mine to get iron for his consumption in the copper mines. Wood is sufficient in the neighbourhood for Native smelting.

No. 12. *Bomutotha Cherry Khan* is situated about half a mile South of Soogee village, near Chutnapeopul, in Mullah Nagpore. The mine is high on the side of the mountain ; its lode, which is about 3 feet wide, bears N. N. W. and S. S. E. and dip at an angle of 10° E. N. E. ; is chiefly composed of quartz, with micaceous and specular iron ore, of good quality, but not abundant. Several rich specimens were taken from the North side of the lode, but they do not yield supplies for furnaces. It is embedded in a bluish clay slate. It appears iron is not wrought here, or only in such quantity to meet the lessee's consumption. Wood is abundant.

No. 13. *Hartjasal Iron Mine* is situated about a mile West of Hart village, in Mullah Nagpore. The lode which is seen cropping out for 8 fathoms wide, is composed of micaceous specular and brown iron ore, with occasional layers of blue clay and quartzose slate. Its bearing is N. N. E. and S. S. W. and dips W. N. W. at an angle of 20° . The ore is very rich and abundant : it is quite accessible, and in about one hundred fathoms from the North banks of the Aluknunda River, although very rich, little is doing on it. The lesson only pays 4 Rupees per annum, which shows that iron is not of much value so far back in the mountains. Wood is not very abundant on the mine or in its vicinity, but sufficient for Native smelting.

No. 14. *Harthakhan Iron Mine* is situated about a quarter of a mile West of Hart village, in Mullali Nagpore, in the side of a very steep mountain, the excavation, rather than a mine, is commenced in the out-crop of the lode which is wrought for about 12 feet long and 12 feet wide in a mass of pure micaceous iron ore of 75 per cent. metal. The lode is seen for a considerable breadth and very rich, but very little has been done to turn it to profitable account (this is a continuation of Hartjasal lode.) Smelting is not spiritedly carried on here, the Natives only mine and smelt for their own consumption. Wood is very scarce on the mine, but close on the South side of the Aluknunda, the mountains afford plenty for mining and smelting purposes. Limestone can be had in any quantity both on this and Hartjasal mine. If there had been any call for iron in those districts, these mines would supply any quantity. Thousands of tons of rich iron ore are already broken and lying on the surface.

No. 15. *Bejouragurd Iron Mine* is situated about a quarter of a mile South of Palsonee village, in Puttee Kerrakate, (pergunnah Beedhan.) It is high and accessible in the side of the mountain. Very little has been done on it. Attempts to smelt the ore has been made, but iron could not be obtained from it. The lode is about 12 feet wide, bearing East and West, and dips about 30' North. Its composition is quartz blue-clay slate, a little iron, and *blende*, with occasional spots of lead ore. It is encased in a quartzose stratum, but very poor and offers very little inducement for further exploration. The Pinder River passes just under the mine. The farther West at Narinebugnah is the Rajah Khan Iron Mine in the same lode, where considerable old workings are to be seen grown over with brushwood ; the new mine here on the eastern part of the old workings, sealed in the last wet season ; this opening yielding good ore, and the Natives inform me it is rich, and if explored, would yield abundance of rich iron ore.

Fourth.—Old Iron Mines investigated are the Dunda, Davee Khan, Rajah Khan, Mokka Khan, and Calabun.

No. 16. *Danda Iron Mine* is situated about a mile North, and above the Doongra village, in Dewulgurh. It has a great many old shafts or openings, but are all at present choked, which prevented internal investigation. It has been suspended for the last ten years. A resident guide informed me, the lode was at times as much as 3 feet wide, and at others dwindles almost to nothing ; the ore is a common brown iron ore, not very rich. From a few specimens collected on the surface, it appears to yield

about 30 per cent. metal. About 30 fathoms below, immense detached rocks of ore are seen cropping out the surface, of a little better quality, but so hard that the miner and smelter reject them. The lode bears about East and West, asvestas is also found mixed with the ore. Above the mine a large formation is seen cropping out, where abundance of limestone is procurable. It is my opinion the mine is worked in a broken stratum, (a land-slip;) and that the mean lode is above ; the miners had great difficulty in keeping abroad their galleries, the rock being so broken up, which evidently shows the whole mass, on which the mine is worked, came down from above, and if explored, without doubt, a large and rich lode would be discovered. Wood for charcoal and mining purposes is rather scarce in the immediate neighbourhood, but about 3 miles up the Butchingurd Valley, there is plenty of prime oak, and also on the Butchmone Mountains about 3 miles South of the mine.

No. 17. Davee Khan Iron Mine is situated about one hundred fathoms South-East of Doongra village, in Dewulgurh. It had several openings but at present, are all sealed in and choked. It appears this mine, like the Danda, is not worked on the rock, in its primitive position ; the Native miners inform me, they sink pits in the rubbish that previously came down from the great formation above, from very near the summit of the mountain, in which they find rocks of iron ore (no regular vein) sometimes rich, and at others very poor, and cannot sink or drift far because their galleries fall in and fills the mine with rubbish. It may be called quarry rather than mining. This mine has not been suspended long, and when last in operation, it supplied 13 furnaces for about three mouths in the year, which were situated in the following villages, *viz.* : Bawuso-ore, Gober-ore, Darnacote-ore, Tailecte-ore, Surraree-ore, Coilce-ore, Pata-ore, Peepulee-ore, Paroh-ore, Gubar-ore, Chundee-ore, and Domgratwo-ore. It does not appear they used to carry much iron to market ; they only get a little for their own consumption, and the supply of a few minor villages, who take no part in the mining and smelting. These mines cannot be very profitable to them, looking at the distance they have to fetch charcoal and the hazard in the supply of mineral which must be all calcined before they can smelt it. The old lessees paid 25 Rupees per annum, and if they obtain a new lease, at the same rent, they cannot make much profit. The miners are generally very poor. The Natives, who are very numerous and very poor, are desirous to obtain a new lease ; the mines are better leased and kept in operation than left idle. They will be kept

open and saved from ruin. It is very likely English capital will be invested in iron in this locality, however the mines will do to lease to the Natives who will be paying a trifle to Government and keep them from idleness.

No. 18. *Rajah Khan Iron Mine* is situated about three quarters of a mile South-East of Augur village, in Puttee Nagpore. It has several entrances, several of which are choked. The main entrance or excavation is wrought for about 15 fathoms in a westerly direction, and in places for 4 fathoms wide ; the lode bears East and West and dip about 30° North. Its breadth is from 10 to 15 fathoms wide, of brown iron ore of from 25 to 30 per cent. metal. It supplies three furnaces in Augur village and several others in scattered villages in the neighbourhood. At the entrance of several old galleries, which are choked within in the South side of this enormous formation, several stones, containing copper, were found, viz. copper pyrites, grey sulphurat, and green carbonate of copper. It is encased in a tât case slate. Wood is sufficient in the neighbourhood for Native smelting only.

No. 19. *Mokka Khan Iron Mines* are situated in the summit of Kalloo or Katoolee Mountain, about two miles South of Moh village, in pergumali Budhan. They are not very extensively wrought at present ; numerous old mines are abandoned and sealed in. The lode bears N. N. W. and S. S. E. and dip E. N. E. at an angle of about 50°. The present mine, which is open, is worked in a direction at right angles with the lode in a mass of steely black oxide of iron (magnetic) of 70° per cent. It is so compact and hard, that the Natives are obliged to burn the ore before they can extract it. It is a superior fine, hard, valuable iron and very much prized by the Natives. It appears to be worked by the inhabitants only when necessity requires, then each person mine and smelt for himself, according to his wants. Any quantity of very rich iron ore can be obtained from the mine, and the extensive oak, pine, and deodar forests in the mines are inexhaustible. The breadth of this rich iron lode is not to be ascertained ; the miners do not work or carry the whole breadth of it in their excavation, and the surface is completely covered with brushwood and trees which prevent seeing the out-crop to ascertain it there ; but from the direction of the old mines, it must be a great many fathoms wide. It was traced in a southerly direction in our journey to Jak for 4 or 5 miles ; and several old abandoned mines, and remains of ancient smelting works, are to be seen in it.

No. 20. *Calabun Iron Mine* is situated in the South side of Budhan. It has two openings, the North one, which is scaled in, is about 3 fathoms deep, the southermost about 4 feet deep. From this the miners extract their ore. The lode which bears North and South and dip about 40° East, is composed chiefly of specular iron ore, of from 60 to 70 per cent. The metalliferous part is about 4 feet wide, encased in a coarse grey porphyry (the mountain generally is granite.) There is no smelting works in operation within several miles of the mine. Each person according to his wants mine and carry the ore to his village and smelt it, paying a certain tribute to the ticcadar or lessee on the ore extracted. The lode is very rich, and the iron of a superior quality, and can be raised in abundance. If at any time this mine should be required to be worked on a larger scale, and smelting works should be established in or near the mine, inexhaustible supplies of fuel can be obtained from the extensive oak, pine, and birch forests, which cover the mine and its vicinity for miles around. Water can be had in sufficient quantity immediately under the mine.

Fifth.—Lead Mines examined are Raie, Chendâk, Kerraye, Patal, Dhunpore and Jâk.

No. 21. *Raie Lead Mine in Gungolee* is situated about a quarter of a mile North-East from Raie Copper Mine. It has one opening or irregular shaft which is nearly filled to the surface with rubbish. No lode or mineral of any kind can be detected either in the shaft or in the stratum, which is denuded and exposed around it. At surface it is in a limestone formation, and the workings appear to be inconsiderable. It is worthless from present appearances, but if cleared, or re-opened, might recommend itself, (no one remembers it in operation or have seen any mineral from it.) It does not recommend itself from present indications, and in my opinion, is not worthy of further exploration.

No. 22. *Chendâk Lead Mine* is situated about two miles East from Chuna village, in Goron. It has three openings in the out-crop of the lode nearly on the summit of the mountain. In the middle or deepest, extensive working has been made. On the dip of the lode which bears W. S. W. and E. S. E. and dip at an angle of about 60° N. N. W., it is embedded in a compact limestone; and the lode which is from 6 to 8 feet wide, is chiefly composed of limestone, with small veins of quartz, in which the lead ore is very securely deposited. Wood for smelting and mining purposes cannot be obtained within several miles of the mine; and water

for cleansing cannot be had within two or three miles. Looking at the hard extensive rock, it is embedded in the scarcity of wood and water and the insufficiency of minerals, it appears no inducement whatever for outlay or trial, nor can any miner recommend it from the appearance of the lode or the indications it generally presents.

No. 23. Kerraye Lead Mine is situated on the top of Tapolee Hill, about 2 miles North from Kerraye Copper Mine, in Puttee Kerraye, (pergunnah Chewgurka.) No regular lode can be seen. Stones containing lead ore are met with throughout the limestone formation, which is several fathoms wide, bearing North and South. Several old mines or pits are sunk on the top of the hill, most of which are scaled in and grown over with trees and brushwood. It is a very hard, compact limestone, very thinly impregnated with the lead ; the whole hill appears to be slightly metalliferous, but so thinly deposited, and the rock so hard and difficult to wrought ; it offers no inducement for either public or private capital. No one remembers it in operation. Supposed to be worked last by the Goorkhas.

No. 24. Patal Lead Mine is situated a quarter of a mile North of Patal village, in Dewulgurh, on the North side of the Butchingurd River. On finding its entrance choked, employed men and cleared it so as to enter 18 fathoms in the mine. The level or gallery which is very small, is driven on the course of the lode, which bears E. N. E. and W. S. W., and dip at an angle of 45° S. S. E. At the entrance it is about 8 inches wide, and about 6 fathoms it is 2 feet wide of quartz ; it does not show a particle of mineral, but has a very promising appearance. At the end of the main gallery a cross-cut or branch gallery is extended North, where it intersects another lode chiefly composed of quartz, on which a sink or diagonal gallery is made on the dip of the lode which was full of water. The main workings are all under this level and filled with mud and water which prevented examination. Considerable working has been made, and from the great quantity of Scorins laying on the surface, evidently shows the mine once to have yielded mineral. It is situated convenient to water-power, and wood abundant for charcoal and all mining purposes. The lode is embedded in a beautiful blue clay slate which is a very congenial structure for lead. An adit or gallery for the extraction of ore and which would serve for drainage, could be put in at a trifling expense, to drain the old workings and give it a trial.

No. 25. Dhunpore Lead Mine is situated in the side of a steep mountain at Rullecan Dhonuka Dookeka, about two miles South-East from

Dhunpore village. It has two entrances or diagonal galleries sunk on the dip of the lode, the westernmost one about 3 fathoms, and the other, which is about 4 fathoms East, is 10 fathoms deep. It appears, the old miners met with a shoot of ore (lead ore) in the out-crop, and followed it down in an easterly direction on which considerable workings have been made. In breaking some of the lode we found it thickly impregnated with lead, and in the gossan (a brownish decomposed quartz) the green carbonate of copper. In the western workings, a good deposit of lead is to be seen from which we broke 13 seers of good lead ore. In this sink no very extensive workings have been made but far richer than the eastern ore. The lode bears East and West and dip about 40° South into the hill. Its breadth cannot be ascertained from the out-crop being thickly grown over with trees and brushwood, &c., nor can it be ascertained in the mine; the miners did not carry the whole breadth of it in their workings, only one wall (side) is to be seen, the North one. It is worked on for about 12 feet wide, chiefly composed of a brownish quartz, mixed with a little limestone, the whole thickly impregnated with granular lead (galena). Although this mine has not been leased, the Natives of the neighbourhood have worked it occasionally, probably for the lead or silver or both, (it is doubtless argentiferous.) It is so situated that any required depth of adit or gallery can be brought in for drainage, but being situated so high, drainage will not be required for a considerable time, if worked with great force. It was left rich. Ore can be broken at once and a stream, less than a quarter of a mile from the mine, affords sufficient water for dressing and all other mining purposes. If this mine was in Cornwall, with such facilities as is here offered, it would let at five (5) shillings in the £, or one quarter of the produce, and great profits would be realized from it. Wood for charcoal and all mining requisites can be obtained on and directly East of the mine. The 13 seers of ore were taken back to Dhunpore, and after selecting the best specimens to take back, and samples to ascertain the proportion of silver smelted; the remainder or refuse, which was about $11\frac{1}{2}$ seers of ore, produced $1\frac{1}{2}$ lb. of lead, equal to 6 $\frac{1}{2}$ per cent. It was not dressed or cleansed and smelted, less the best specimens with the dirt as taken from the mine.

No. 26. *Ják Silver Lead Mine* is opened close to the western end of Ják village, in Puttar Kurra Kote, (pergannah Bindhun.) At the place where the silver lead (argentiferous galena) was found, we commenced opening, and found the lode, which was very much disordered, and the

stratum very much broken, to bear S. E. and N. W. and dipping N. E. It is composed chiefly of quartz, mixed with clay slate, which make at intervals rich deposits of lead ore; and stones from 2 to 15 lbs. weight have been extracted from it which will yield 50 per cent. lead. . Being so near the surface, it does not take a regular bearing, (inclination,) but if explored, would in depth be found more settled and probably productive. It has every indication of becoming a valuable lode, and I strongly recommend to sink a shaft 10 fathoms diagonally on its dip, which will give it a little trial. About 150 lbs. of lead ore were taken from the lode, and rubbish, which will yield 25 scours of pure lead, equal to $33\frac{1}{3}$ per cent. It is embedded in a greyish clay slate. Such metalliferous and promising lodes deserve trial, and the specimens found will recommend it. About 300 Rupees will prove it 10 fathoms deep, including the expense of drifting a few fathoms East and West in its course at the bottom of the shaft. If a good mine should be met with here, wool, (prime oak,) within a short distance, is inexhaustible; and water, for all mining purposes, can be had just under the mine from the Pindar River. Every facility is here offered for carrying on extensive mining operations which can be carried out very economically. The lead of this mine will yield silver and should be assayed to ascertain the exact proportion. If the mine was worked in a mining-like manner, it is my opinion that it would be found rich and remunerative. This lode is also seen cropping out by the side of the road leading from Jâk to Biengong village. About 80 fathoms, in a South-East direction below the mine, where it is more settled and has a very promising appearance, a small trial should be made in the out-crop at this point also.

It will be seen that of the Lead Mines Dhunpore and Jâk are the most promising, and can, doubtless, be made, with little outlay, remunerative. If lead should be required in the hills "it can be raised at once in Dhunpore Mine, and if it should prove argentiferous (of which there is no doubt,) it will be found a valuable concern and could be profitably worked, looking at the enormous price lead sells at, *viz.* £10 per ton."

No. 6. Gold. In travelling we discovered parties washing the auriferous sand of the Aluknunda, and from the gold obtained from a certain quantity of sand, it appears to be very profitable to them. Gold is very much worn by the inhabitants in rings and other decorations, which I was informed is taken from the rivers. We found by trials made also on the Pindar and Memduknee Rivers, that the sands were auriferous and the precious metal detected in each of them, the Aluknunda by far the richest. If

washings were carried out on a large scale by the new improved methods for washing and obtaining gold, where labour is so cheap, without doubt, could be turned to profitable account.

Several other mines, besides those previously mentioned, came under my notice, but not worthy of place here. It appears there are in Gurhwal a great number of metalliferous deposits which have not yet been visited by Europeans, many of which bordering on the lower range of the Himalayas, if examined could be prosecuted and probably turned to profitable account.

I beg to say that my companions through our tours laboured zealously, as well as myself, to promote the objects of our mission, the results of which, I hope, will meet the approbation of our employers and also of the Commissioners of the Provinces who were pleased to appoint the investigation.

I have, &c.,
 (Signed) JAMES BARRATT,
Assistant Mineral Surveyor.

List of Mineral Specimens collected from the various Mines examined.

Number of Specimen	Names of Mine.	Names of Miner.	Names of Pattee.	Province.	Remarks.
No. 1	Pepalee	"	Copper pyrites	Burding- gard	" Not opened.
" 2	Pringhpani	"	Copper pyrites, black & white, and green;	Girhwal	Explorations limited.
" 3	Mudugrette.	"	carbonate of copper	Ditt:	"
" 4	Kerray	"	No specimens	Ditto	"
" 5	J. lar	"	Yellow pyrites and purple copper ore K. graye	Kumon	" Extensively wrought, but not rich.
" 6	Fair	"	Black oxide of manganese	Ditto	" Abandoned.
" 7	Serra	"	Copper pyrites in slate	Ditto	" Ditto.
" 8	Tomato-tree	"	No specimens	Ditto	" Ditto.
" 9	Hobree	"	Purple copper and green sulphide	Girhwal	" Suspended for the present.
" 10	Dhunpore	"	Purple copper ore and copper py- rites	Ditto	" Extensively wrought & rich.
" 11	Hadersain	"	Vitreous copper pyrite and purple	Ditto	" Ditto.
" 12	Bon aetha	Cherry	copper ore	Ditto	" Ditto.
" 13	Khan	"	Red oxide of iron and red ha- mmerite	Ditto	" Oro abundant & very rich.
" 14	Harijash	"	Miraceous and peculiar iron ore	Nagpore	" One very scarce
" 15	Hartabhalan	"	Miraceous and brown iron ore	Ditto	" One very rich and abundant.
" 16	Pisourangar	"	Miraceous iron ore	Ditto	" Ditto.
"	Landa	"	No specimens	Ditto	" Ditto.
"		"	Brown iron ore	Burdin-gard	" Suspended for the present.

List of Mineral Specimens collected from the various Mines examined.—(Continued.)

Names of Mines.	Names of Mineral.	Names of Miner.	Province.	Remarks.
No. 17	Brown iron ore.	Brodingurd	Garhwal	Suspended for the present.
" 18	Br. iron	" N. Spone	Ditto	Ore abundant, but not rich.
" 19	Mokha, Khas.	Kurrakote	Ditto	Ore abundant & very rich.
" 20	Columb.	Pinderwar	Ditto	Ditto.
" 21	Ride.	" Dito	Ditto	Not open.
" 22	Chendrik	" Ditto	Ditto	Abandoned.
" 23	Kerrye	Korraye	Kumaon	Very poor.
" 24	Lead	" Ditto	Ditto	Not in operation.
" 25	Dhaspore	Dhanpore	Gurjwar	Very promising. Not in operation.
" 26	Juk	Kurkote	Ditto	Ditto ditto.

(True Copies)

(Signed)

R. N. OLDFIELD,
Asstt. Secy. to Govt., N. W. P.

Copy.

Dr. No. 24.

Abstract of Mineral Survey Civilish Account

Cr.

30th Sept. 1855...	To Balance	22	7	4	13th Oct.	1855 By Advance at Almora Treasury	600	0
" October Expenses	300 0 15 4	25th	date	" Bill from Mr. Wallace for Hrass and Iron Works for Model Fan			2	4 9
" November Expenses	240 15 0							
" December Expenses	420 4 7							
" January Expenses	241 11 4	12th Nov.	1855 "	Advance at Almora Treas- ury	..		500	0
" February Expenses	211 12 1							
2nd. F.A. 1856. By Balance in hand	393 0 1	16th Jan.	1856 Advance at Almora Treasury	..			800	0
Total, Cr's. Rupees	1902 1 9					Total, Cr's. Rupees	1902	4 9

(Signed) JAMES BARRATT,
Asst. Mineral Surveyor.

Haridwar, 29th February 1856.

No. 92.

FROM

CAPTAIN H. RAMSAY,
Commissioner, Kumaon Division,

TO

THE SECY. TO THE GOVT. OF INDIA,

Home Department,
Calcutta.

PUBLIC WORKS.

Sir,

I HAVE the honor to inform you that, under instructions from the Hon'ble the Lieutenant-Governor, North Western Provinces, I have this day sent to the Allygurh Post Office, to be forwarded thence by the Bullock Train, a Box to your address, containing specimens of Iron Ores.

I have the honor to be,

Sir,

Your most obedient servant,

H. RAMSAY,

Commissioner.

KUMAON COMM'R'S OFFICE; }
Camp Haldwani, }
The 2nd March 1856. }

BHABUR IRON ORES.

List of Specimens, with Remarks.

	No.	Locality.	REMARKS.
GULB.	1	Beejapoore,	Heavy and rich.
	2	Ditto,	Tufaceous lime-stone.
	3	Pepnl. Pokree,	Workable, 2 feet bed.
	4	Muchear,	3 feet bed, clayey and poor, good for mixing.
	5	Punealee,	Micaceous, sandy and poor.
	6	Ditto,	Bog ore, workable.
	7	Chewnsillu,	Narrow bed, poor, but workable.

List of Specimens.—(Continued.)

	No.	Locality.	REMARKS.
BOMBAY RIVER.	8	Bhoomka,	Good ore, very serviceable.
	9	Ditto,	Poor but serviceable.
	10	Dechouree,	Bottom of shaft 20 feet deep.
	10a	Ditto,	12 feet below surface green clay.
	11	Ditto,	From blocks on surface very rich.
	12	Ditto,	Ditto ditto ditto, rich.
	13	Ditto,	Ditto, calcined.
	14	Ditto,	White sand-stone.
	15	Ditto,	Red ferruginous clay, useful for reducing.
	16	Ditto,	White fire-clay, requires well preparing.
	17	Ditto,	High up in the hill, good ore.
	18	Ditto,	Ditto ditto, hydrated ditto.
	19	Ditto,	Ditto, poor bog ore.
	20	Ditto,	Clayey slate, with stains of iron.
	21	Ditto,	Lime-stone from Dechowree gool.
DUMKA.	22	Sidie	Surface, specimen poor.
	23	Gulmenee,	Ditto, ditto very poor.
	24	Ghatsoorah,	Workable ore, very fair.
	25	Ditto,	Clayey, workable.
KIRCHEREE.	26	Umaralee.	Good workable ore.
	27	Ditto,	Ditto ditto.
	28	Ditto,	Ditto ditto.
	29	Ditto,	Poor, but workable.
	30	Pat Koi,	Ferruginous Quartz refractory.
	31	Ditto,	Refractory.
	32	Bhara Koi,	Ditto Quartz.
	33	Ditto,	Ditto Quartz.
	34		
	35	Ghattee Paher,	Poor, but workable.
	36	Choopra,	Ditto, ditto.
KOSILLA.	36	Moudi Gharee,	Ditto, ditto, much on surface.
	37	Dongar Nuddee,	Heavy rich and iron ore.
	38	Ditto,	White clay interspersed.
	39	Easoad,	Poor, much on surface.
	40	Chookan,	Workable, small bed.
	41	Choopra,	Lime-stone, tuba con.
	42	Kossilla,	Ditto ditto.
	43		
	44	Ghurrur,	1 feet bed, poor but workable.
	45	Ramgunga,	Small bed, poor.
	46	Ditto,	Ditto ditto.
	47	Ditto,	Below Ghurrur good workable ore.
RANGOGA.	48	Boxsur,	Lime-stone fusaceous, near Ghurrur.
	49	Patlec Doon,	Fair, workable, much on surface.
	50	Ditto,	Workable.
	51	Ditto,	Poor workable, } Road to Choulcherree.
	52	Ditto,	Very poor workable, } Ditto ditto.
	53	Ditto,	Ditto ditto.
	54	Ditto,	Ditto ditto.

List of Specimens.—(Continued.)

	No.	Locality.	REMARKS.
PALA EN.	55	Chouleherree,	... A kind of bog ore, poor.
	56	Ditto,	... Heavy rich.
	57	Karee,	... Much on surface, good, workable.
SUSA.	58	Karee,	... Much on surface, heavy workable.
	59	Kotree,	... Refractory but workable.
	60	Ditto,	... Workable.
	61	Kotdware,	... Very serviceable iron-stone.
KOH. SON.	62	Ditto,	... Very excellent serviceable ore.
	63	Ditto,	... White fire-clay, good.
	64	Ditto,	... Workable but poor.
	65	Lal Dak,	... 3 feet bed poor
ROWA- SON.	66	Ditto,	... 2 feet ditto, ditto.
	67	Ditto,	... Very ditto, ditto.
	68	Ditto,	... Very poor, 2 feet 6 inches.
	69	Mundil,	... Poor, small bed, contains lime.
GANGES.	70	Ditto,	... Ditto ditto ditto.
	71	Juninea Bagh,	... A kind of bog ore, rich specimen.
	72	Ditto,	... Heavy and rich, but refractory.
	73	Ditto,	... Ditto, but not rich.
	74	Tal Nuddee,	... Poor and refractory.
	75	Ditto,	... Ditto ditto.
	76	Ditto,	... Rich, heavy, and refractory, broken from the large mass sent to Roorkee.
	77	Ditto,	... Rich, but refractory.
	78	Ditto,	... Killas, poor.
	79	Ditto,	... Carbonaceous slate impure.
	80	Ditto,	... Ditto very impure.
	81	Ditto,	... Lime-stone, fusaceous.
	82	Kotdware,	... Lignite coal.
RAMB. GANGA.	83	Dohuleund,	... Good workable ore.
	84	Ditto,	... Workable ore.
	85	Khalagurh,	... Poor.
	86	Lol Jhung,	... Workable iron-stone.
	87	Dehla,	... ditto ditto.

(Signed) W. SOWERBY,
Civil Engineer.

DECIOUREE,
The 30th January, 1856. }

No 301 A. OF 1856.

FROM

WILLIAM MUIR, ESQUIRE,
Secy. to the Govt. of the N. W. Provinces,
 To CECIL BEADON, ESQUIRE,
Secy. to the Government of India,
Home Department,
 FORT WILLIAM,

Dated Head-Quarters, Nynce Tal,
The 3rd May 1856.

PEBBLE WORKS DEPARTMENT.

SIR,

I AM directed by His Honor the Lieutenant-Governor to transmit, for the purpose of being placed before the Right Hon'ble the Governor General in Council, the accompanying copy of a Memorandum, dated 22nd instant by Lieutenant-Colonel H. Drummond, employed on iron investigations in the Bhawali, explanatory of the failure this year in the effective working at the furnace at Dechouree.

2nd.—The memorandum states the circumstances under which some small excellent specimens of pig iron were produced, two of which, with a specimen also of the impetuously melted iron which presents appearance of a highly favourable character, will be transmitted to your office by the Government Bullock Train. It will suffice to show the good working character of the ore.

3rd.—The Lieutenant Governor would recommend that, if Lieutenant-Colonel Drummond should be permitted to proceed to England, as proposed in my separate letter, No. 295 A of the 30th April, he should be authorized to engage the services for two years of two founders to assist Mr. Davies, who, though very qualified and zealous, is unable, without further European help, to make proper use of the furnace which has been prepared under his direction. It is obviously desirable, whatever resolve be formed in regard to more extensive plans, that a fair and complete trial be made of this experimental furnace, which has failed in the past season only from the want of a sufficient number of qualified workmen. The pig iron produced at this furnace will supply nearly the whole of the yearly demand of the Roorkee work-shops.

4th.—A memorandum with plans, submitted by Mr. Sowerby, and sent with this letter, contains further details of the endeavour to use the

furnace, and of the particulars connected with the Dechouree works, which will be interesting as a guide in further operations.

I have the honor to be,

Sir,

Your most obedient servant,

W. MUIR,

Seey. to Govt. N. W. Provinces.

*Head-Quarters, Nagpur Tal, }
The 3rd May 1856. }*

MEMORANDUM ON THE RECENT IRON SMELTING OPERATIONS EXPERIMENTALLY CONDUCTED AT DECHOUREE.

THE water wheel for supplying the blast having been completed on the 17th March, the heating and charging of the furnace commenced on the 18th, and continued till the 24th, when the blast was put in.

2nd. Shortly afterwards it became apparent that the air-chest was leaking from the shriveling of the timber of which it was composed.

3rd. The leakage increased to such an extent that it was deemed prudent at midnight to stop the operation.

4th. On clearing out the furnace, it was found that the ore had commenced smelting in the most satisfactory manner. Amongst the lumps of metal there was what is called usually "keeshy" iron, (iron highly carburetted,) which is always regarded as a sure prognostic of the cast-iron being of the best description.

5th. Mr. Davies, the smelter, was naturally disappointed at the necessity for suspending the operations, but so certain was he of eventual success that he at once placed the metallic lumps which had been removed from the furnace into a small empola which had been made for brass castings, and without difficulty ran them into pigs, a portion of one of which is herewith submitted, and will be found to be cast-iron of the very best quality, and would take the first place in any market.

6th. To obviate the possibility of leakage again occurring, the air-chest (which for its large dimensions was found exceedingly difficult to render perfectly close at all the joinings) was omitted, and the air pipes led at once from the valves of the blast trunks to the tuyeres.

7th. The furnace was again heated and charged on the 10th, 11th and 12th instant, during which time it required constant and unremitting attention.

8th. On the 13th, the blast was put on about the middle of the day, and the whole operation progressed most favorably for about twelve hours, when the cinder began to descend with such rapidity as to require greater strength and activity to clear the hearth and raise the cinder than one man could accomplish.

9th. Mr. Davies was able by the most violent physical exertions to keep the work going for some hours after this, but the labor entailed upon him, combined with his previous constant watching, tasked his energies beyond their power, and his strength began to fail, when an accident to his eye entirely disabled him.

10th. The work was continued till day-break on the 14th, by Native workmen under Mr. Sowerby's superintendence, but not being possessed of the requisite skill, they were unable to prevent the accumulation of the cinder in the hearth, and consequently the liquid metal could not be drawn from the furnace.

11th. After the blast was taken off and the hearth cleared, a quantity of iron was taken out of the same description as that which was produced on the former occasion.

12th. To sum up. The work has been stopped only from want of trained hands. It being late in the season, and Mr. Davies having been taken ill, I considered it advisable that the prosecution of the undertaking should be discontinued for the present.

13th. It is satisfactory to add, that Mr. Davies states, that in the course of his 34 years' practical experience, he never saw materials which worked more favorably together and better adapted for the production of cast-iron of the best quality.

14th. The furnace on being cleared out was found to have sustained no damage, the fire-bricks leaving stone well. As an experiment the success is so far complete that it need hardly doubt, that at Dechouree, the means of producing cast-iron of the best description exist in the greatest profusion.

(Signed) H. DRUMMOND, *Lieut. Colonel,*
On Special Duty.

NYNEE TAL,
The 22nd April 1856. }

(True Copy.)

W. MUIR,
Secretary to Govt. of the N. W. Provinces.

HIMALAYAN IRON WORKS, KUMAON.

REPORT ON THE EXPERIMENTAL BLAST FURNACE AND OTHER WORKS AT DEOBOOREE.

Introductory Remarks.

1. On first commencing the works in the beginning of November of last year, considerable difficulty was experienced in obtaining proper workmen, owing to the work being of a new kind in the country, also in obtaining a proper supply of suitable tools, not the smallest previous preparation having been made to supply either workmen or tools, and the great distance of any important station from whence they could be obtained, the nearest being Meerababad or Rampoor about 50 or 60 miles off, caused some delay in the outset. Some tools were supplied by the Commissioner of Kumaon, with as little delay as possible. The workmen who applied for work were all of them of an inferior class and the tools they brought with them were quite unfit for the kind of work to be done. A few better workmen were engaged as the work progressed, but when once men were employed and got a little used to the work, it was inconvenient to change them.

2. In any future works to be done, proper arrangements should be made for engaging good workmen some little time previously, also in the providing of an adequate stock of good tools, when the inconveniences experienced during the progress of the present works would be avoided. The workmen should be engaged for a longer period than from month to month, to prevent their leaving in the middle of the work as some of them did during this season.

THE FURNACE.

3. The foundations having been dug for the furnace, the building of it was commenced about the middle of the month of November. The foundations are built of undressed rubble masonry, the adjacent boulders being split and laid in mud and grouted with the white clay made into a semi-liquid state, and poured into the spaces between the stones; this made a tolerable solid foundation. Lime as mortar would doubtless have been much better, but none having been previously prepared, and the length of time required for burning it, also the want of tools, prevented its being got ready in sufficient time, particularly as the work required to be completed within the working season which had already fairly set in.

4. The whole of the upper walls of the furnace are also built of rough rubble masonry, set in a mixture of lime and mud, the lime being

chiefly brought from Kaleedoongee, where there was a good stock in hand previously prepared. The stones used in the building of the furnace were procured from an adjacent quarry ; the workmen however could not dress them properly.

5. Should any more furnaces be erected in this locality, it would be better to have them built entirely of bricks instead of stone, the stone-masons being such inferior workmen. If a better class of masons can be procured, then stone, which is very plentiful and of a good kind, would probably be the best and cheapest. Furnaces do not of necessity require to be of very fine dressed masonry, the stone only requires to be properly squared.

6. An experiment was made in the manufacture of common bricks from some of the soil in the neighbourhood, about 3,700 having been moulded from some clay found ready puddled, and the result was that the bricks were very good, and the clay most suitable for their manufacture. The clay is found about $1\frac{1}{2}$ mile from where the furnace has been erected.

THE FIRE-BRICKS.

7. On commencing the manufacture of the fire-bricks, considerable difficulty was experienced owing to the material being quite new to the Native workmen and the workmen not being first rate. After about 500 had been made and burnt, the work proceeded in a more satisfactory manner, the workmen having gained confidence in the material.

8. Here again the necessity for urging on the work as rapidly as possible rendered it necessary in order to save time to use the bricks in an unburnt state, this was an uncertain experiment but the great care taken in the burning of them in their place inside the furnace prevented any bad effect.

9. The quantity of fire bricks made was about 11,000, and have been used as follows :—

Number used in furnace burnt,	...	500
Number do. do. unburnt,	...	4,580
Number do. do. in cupola,	...	200
Number do. do. various,	...	100
Number sent to Roorkee,	...	50
Number in stock,	...	5,150
Number spoiled or waste,	...	420
Total,		<u>11,000</u>

10. From the impurities contained in much of the white clay found at Dechouree, it requires to be very carefully selected and prepared in order to make good fire-bricks ; the clay found in many other localities is more free from impurities.

11. As soon as dug it should be first calcined, small charcoal being the best for calcining it ; it should then be ground in a good mill into a fine powder like soovkee, and afterwards mixed with a small portion of the clay and water sufficient to make it plastic. In moulding this would be best done on a good flagged pavement of sufficient area being allowed to remain there till dry ; the bricks if placed on the ground get twisted and spoiled, and frequently crack when drying ; they require also to be turned over and scraped, the loose earth adhering to them, this causes additional labour ; when thoroughly dried they should be burnt in properly constructed kilns with small charcoal. Fire bricks thus carefully prepared would be found equal to the best made in England, which are frequently not prepared with so much care. The proper colour of the bricks is a slight flesh colour, and they are rather tender.

12. The fire-bricks made this season were not made in the above manner for want of time and proper means. They have nevertheless proved sufficiently refractory having stood the heat of the furnace well, the only defect being the cracking of the tunnel head, which should have been hooped with a strong iron hoop.

13. The first fire was lighted in the furnace on the 16th of January of the present year.

THE WATER-WHEEL.

14. The water-wheel that has been constructed for supplying the blast is eighteen feet in diameter and four feet abreast. It has thirty-two buckets, the axle and arms are of saul wood : the buckets and surrounding is of schymul ; the bearings and beams are also of the latter timber ; the cranks, connecting rods and piston rods are of saul. Saul being a strong wood was found most suitable for the parts it was used for ; schymul is a soft light wood and not durable, but the facility with which it could be obtained of proper sizes, and the ease with which it is worked, was the cause of its being used. Jamin is said to be a more suitable timber for water-works.

15. A wheel of the above size, with a supply of 20 cubic feet of water per second, moving at the rate of ten revolutions per minute, is equal to about thirty-horse power more or less. From the small amount

of work it had to perform, in moving the two blast pistons in the blowing cylinders, not more than 5 or 6 cubic-feet of water per second was required, with which it performed twelve to thirteen revolutions per minute, and the same number of strokes in each cylinder. The wheel is therefore capable of working twice as much machinery as it has to work ; it was constructed of this size at the suggestion of the Committee which met at Dechouree in October of last year, under an apprehension that the supply of water would be deficient, and possibly also with a view to the ultimate extension of the works, by the addition of one or more blast furnaces. A wheel of smaller diameter would have been ample for the present experiment.

16. The wheel has been well secured with bolts and screws and paved with a good thickness of tar, also caulked with tarred felt so that it is very substantial. The axle, which is entirely of wood, rests upon brasses, which with the other brasses used were made on the works, being run from a small cupola erected for the purpose.

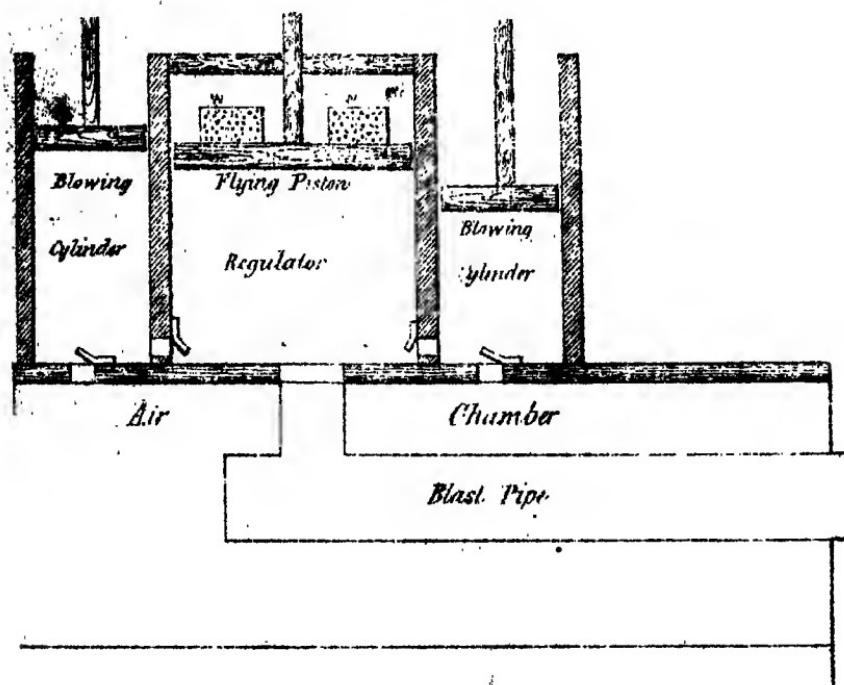
THE BLOWING MACHINERY.

17. The cylinders for supplying the blast are made of deodar timber. They are 3 feet square, and about 7 feet in length. Allowing each piston rod to make a stroke of 6 feet in length, these cylinders with thirteen strokes per minute give a supply of air equal to 1,400 cubic feet ; the quantity requisite for such a furnace as the one erected, is 1,200 cubic feet per minute ; the wood and iron work for these cylinders was prepared at Haul Bagh for a wheel of smaller diameter, otherwise they might have been made 4 to 5 feet square to advantage.

18. The receiver built immediately under the blast cylinders, was built up of stone and lined with wood, well caulked and tarred. It was about ten times the cubical contents of one of the cylinders. This was intended to act as a regulator to the blast, but from the shrinking of the wood, and other causes, it was found on the blast being put on not to be perfectly air-tight, and a very imperfect regulator, the blast being intermittent. When the whole of the machinery is of iron and nicely adjusted, and the air-cylinders are worked by steam-power or well constructed water-wheels, an air-chamber is found to be a sufficient regulator, but any slight deviation from the truth in the adjustment of the machinery owing to its being of wood, causes the blast to be irregular, notwithstanding the air-chamber ; sometimes the intermittent blast is

allowed to be good but generally it is not so. Practical men are slightly at variance on the subject, the regular blast is however preferable.

19. The Air-chamber or Receiver was made at the suggestion of some one of the Committee who met at Dechouree in October last, and not having proved effectual for this particular kind of apparatus. The better plan would have been the introduction of the old fashioned flying piston, as shown in the Sketch below, thus:—



The air being injected from the cylinders into the regulator, the flying piston is forced up and gradually descends, being weighted as shown in sketch. By having cast-iron tops to the blowing cylinders, and wrought-iron piston rods, they could be made double action, working up and down, thereby increasing the effective force of the blast and obviating the necessity for a regulator or air-chamber; this would be somewhat more complex than the plan adopted. The air-chamber having been found defective, the blowing cylinders were subsequently connected with the main blast pipe, by the simple addition of short branch pipes.

20. The blast pipes are also of saul wood, being made out of large-sized hollow trees, split and properly dressed inside, then put together again with tarred felt at the joints and firmly secured by means of strong iron bolts.

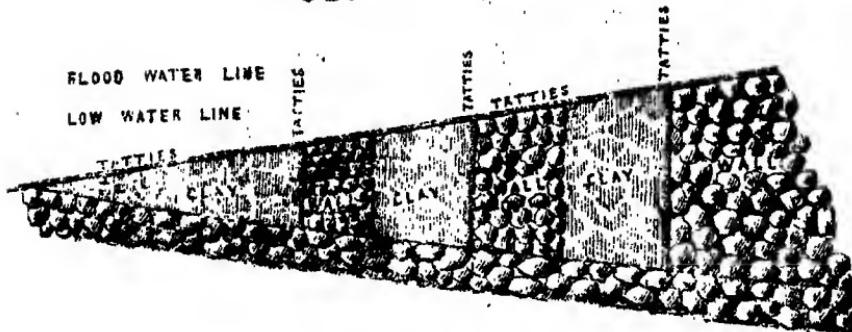
THE BUND AND WATER-COURSE.

21. The construction of reservoirs was suggested by the Committee who met in October last, for the purpose of keeping up the supply of water during the hot weather.

After the most careful enquiries as to the quantity of water likely to remain in the river during the hot months, it was ascertained that it would be quite ample for the present experiment; it was therefore considered unadvisable to construct any reservoirs this season, particularly as they would have been very expensive works, and of very large dimensions to render them of any practical utility.

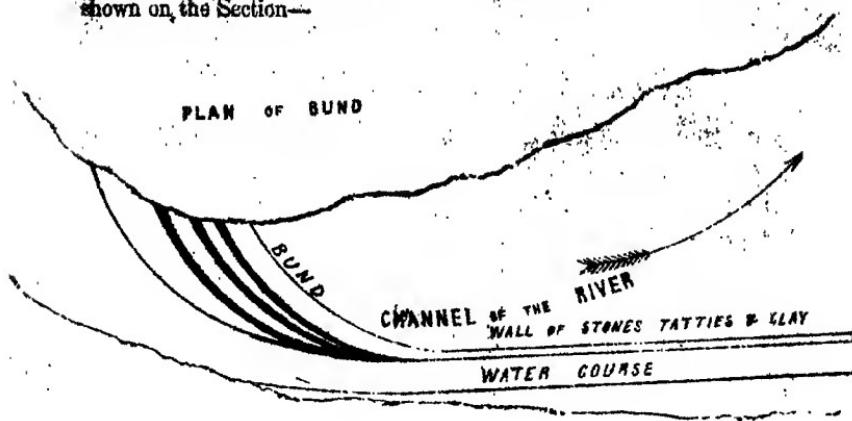
22. A bund was therefore constructed across the river at the head of the gools or water-courses, in order to bring the whole of the water in the river along the upper channel. This bund was constructed with rough boulders and other stones found in and adjacent to the river, according to the following Section, thus :—

SECTION OF BUND.



23. A series of dry rubble walls have been built in an oblique direction across the river, with a slight curve upwards, according to the following Plan, and as shown in the Section above. At the upper sides of these walls tatties made of grass and bamboos were fixed and the spaces between the walls were then filled in with clay and mud and soil—the whole was then covered with other tatties, and a covering of soil and

stones with clay was laid over all, trimming it off to a gentle slope, as shown on the Section—



24. This bund has proved quite effectual in bringing the whole of the water coming down the river into the upper channel which latter has been repaired by contract.

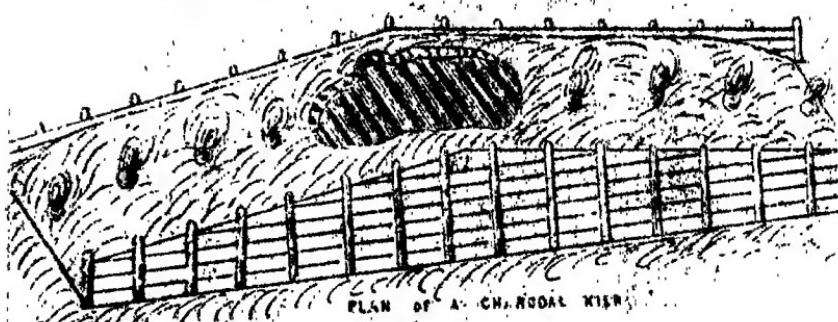
25. The chief difficulty in the construction of bunds or weirs in impetuous mountain streams like the River Boer is that of getting down to the solid rock for a foundation, the bed of the river being generally composed of loose gravel and boulders to a considerable depth, but seldom to so great a depth in this river as to present any very serious obstacles. In making such bunds, it is desirable to select some point in the river where the water flows with the least violence, and where it is not very narrow. The bund should be formed in an oblique direction to the river's course, so that the water would be spread over a long line of over-fall, and would in consequence flow gently over it. If the bund is placed at right angles with the banks of the river, it would be certain to be washed down very soon, and the higher the bund is constructed, the less liable it would be to be washed down, owing to there being a longer space of comparatively still-water above the weir, and the shock of the current being thereby removed to a distance from the over-fall.

THE CHARCOAL.

26. Preparations for making charcoal were commenced at an early period of the season in order to spread the making of it over as long a time as possible, the making of a large quantity quickly, requiring exten-

sive preparations in the shape of planking, &c., for the sides of the kilns. One small kiln and two large ones were constructed, and kept going for several weeks and latterly four large and three small kilns were in operation, but for a short time only.

27. The plan adopted is shown in the following Sketch, thus:—



Uprights are placed firmly in the ground 4 feet apart, the row of uprights for each side being about 9 feet distant. Inside of these upright planks are secured either by wooden pegs, or by having the uprights double and slipping the planks in between them; the latter plan was found to be the best, owing to the facility with which the planks could be taken out and put in, for drawing and charging the kilns. The first kilns constructed were made to slope in one direction only, the upper end being planked like the sides, and the kiln was lighted at one end only. During the progress of the works an improvement was introduced by taking away the back planks and making them slope in both directions from the middle; by this plan the wood was better and more quickly charred, being lighted at both ends and drawn in the same manner.

28. The wood for charring requires to be cut into lengths of 4 feet and piled crossways in the kiln, being well packed; when piled to the proper height the space between the wood and the planks is to be filled with earth and well rammed in, the top being covered with leaves and a layer of soil about 3 or 4 inches thick on the top of the leaves, leaving spaces on the top uncovered until the kiln is fairly lighted. Kilns constructed on this plan with dry wood may be opened and the charcoal drawn at each end within twenty-four hours after being lighted; the better plan however is to allow them to remain eight or nine days as the yield is better and they are more easily drawn.

The height and length of a kiln is quite optional; kilns of 80 feet length and 7 feet high in the middle and 3 feet at each end were constructed, an uniform width of 9 feet was found to be the best.

29. The kind of wood chiefly used was saul, because it was found in such great abundance lying on the ground ready dried, and of no use whatever for any other purpose, having been left there to rot, being rejected by the timber cutters, though they were by no means small trees. The quantity of wood thus available must be immense, as after continuing to use it at one spot for a period of nearly three months there was no apparent diminution in quantity, layer after layer being taken and cut up of quite sound timber, evidently the accumulated cuttings of very many years. Saul wood makes an excellent charcoal, and yields well, as also khyr, buldoo, sissoo, jainin, jingnu, sindoo and aorla; the khyr is excellent but small, it is said to be of rapid growth; the huldoo is very plentiful, the trees being very large; the soft light woods make but an inferior charcoal. Wood of all sizes were used up to 2 feet 6 inches in diameter, which when placed in the heart of the kilns got well charred throughout.

30. The quantity manufactured was about 1,500 maunds or fifty tons, at a total cost of 808 Rupees, including every expense both for building kilns, planks and carrying to the works, thus :—

	Ra. As. P.
31. Cutting planks, &c.,	95 12 0
Building kilns,	138 4 1
Making charcoal,	474 12 6
Leading to Works,	99 14 0
<hr/>	
Total Rupees	808 10 7

32. The actual cost of making the charcoal was therefore about 9 Rupees 8 annas per ton or a little more than 5 annas per maund, and nearly 2 Rupees per ton, for leading the cutting of planks and building kilns being looked upon as plant.

33. At the commencement it was attempted to get the charcoal made and delivered by contract, but though 10 annas per maund was offered for good sized charcoal none but of a most inferior kind and far too small for the furnace was ever delivered. Towards the latter end of the season however a contract for making and delivering the charcoal was

given out at 3 annas per maund and about one-hundred maunds were delivered of tolerably good charcoal; task work was also given out for cutting the wood in lengths of 4 feet at the rate of 10 Rupees per thousand pieces.

34. The labourers employed at first required some little teaching, but towards the latter end of the work they became much more skilful and the work went on in a most satisfactory manner; some difficulty had been apprehended on this head at the outset, and even the bringing out of an European charcoal-burner was thought of. The work however has been found so very simple that an Eurasian boy, sixteen years of age, was capable of conducting the whole operation.

35. The necessity of doing the whole of the work by day labourers caused it to be much more expensive than it otherwise would have been, and the tools used in cutting the wood were of so inferior a kind as to very materially increase the labour and cost of preparing it for the kilns. Towards the latter end of the season a set of new axes were procured from the Roorkee Works, but though of large size and apparently strong implements, they were made of such inferior material, that the first blow generally broke their edges and rendered them unfit for use until repaired, and they required to be constantly repaired afterwards.

36. The quantity of charcoal taken from a kiln 80 feet long 9 feet wide and 7 feet high in the middle, was about 125 maunds. Six of such kilns would therefore be required to keep one blast furnace at work, producing twenty tons of iron per week. This would require the daily labour of 300 coolies for six days in the week, supposing the charcoal to cost 5 annas per maund, and at 3 annas per maund 190 labourers.

37. The making of charcoal will at all times require the greatest attention particularly in the general arrangements, doing as much by task work as possible, where a man and his family can all be employed, as on this the future success of any works will greatly depend. It would be advisable to prepare a good stock during the cold and dry season of the year, as it cannot be properly made during the rains.

38. No very important improvements can be made upon the plan adopted, as it is one of those things, which is in itself so simple and complete that all attempts at improvement would only lead to expense without obtaining any adequate or beneficial result. The details of working the kilns and getting the wood are capable of some improvements, which will readily suggest themselves to any person having charge of the work.

39. After the heavy periodic rains, there is always a large quantity of underwood springs up. This together with the thin branches of trees cut down might be charred in ovens and then compressed into blocks, like peat charcoal at Home in England, Ireland, &c., thus becoming a kind of patent fuel; this together with the small waste charcoal from the kilns, if mixed with tar might also probably form an excellent fuel for the puddling furnaces.

THE TRAM-WAY.

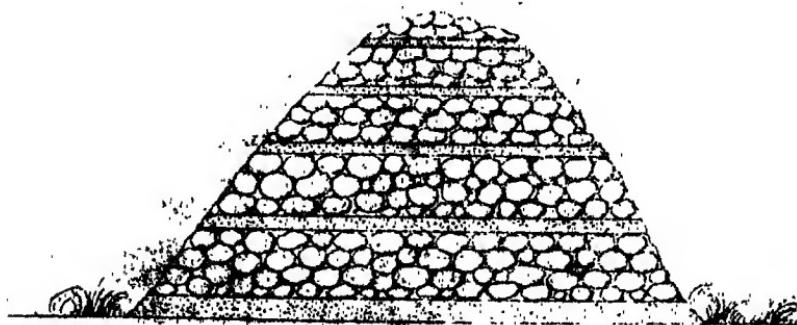
40. The expense and delay, in bringing the charcoal from the forest by bullock-hackeries, would render it absolutely necessary to introduce, at an early period, the laying down of cheap tram-ways.

41. A short piece of wooden tram-way was laid down (and timber cut for a longer) in order to ascertain the cost of such work, and from the data obtained, it has been estimated that the expense would be from 300 Rupees to 500 Rupees per mile according to nature of the ground.

The early manufacture of cast-iron tram-plates would render wooden trams unnecessary, as iron trams are so quickly and easily taken up and laid down so as to suit the work, and are not damaged by being removed as wooden ones are.

CALCINING ORE.

42. Only a small portion of the iron stone was calcined for the recent experiment. The ore when calcined presented the appearance of iron-stone of the best quality; the red ore and yellow hydrated were both calcined and turned out good. A portion was calcined with wood but the best plan is by means of small waste charcoal from the kilns not suitable for the furnace, and always obtainable in plenty. The plan adopted was in heaps, thus:—



43. A layer of charcoal about 3 inches thick being placed at the bottom and then about 2 feet of ore broken into pieces, the size of the fist—afterwards successive layers of charcoal and iron stone, an inch thick of charcoal being sufficient to 1 foot thick of ore. The cost of calcining the ore was about 1 anna per maund or 1 Rupee 12 annas per ton. This may ultimately all be done as task work, by a man and his family being employed.

LIME-STONE

44. The lime-stone is very plentiful on the spot; the cost of preparing it would be merely that of breaking it up into a proper size, which would with good tools, amount to about $\frac{2}{3}$ ths of an anna per maund.

45. The bringing of the lime-stone as well as the iron-stone to the works was by means of coolies; a short tram-way will ultimately be found to be best and cheapest.

TRIALS OF THE BLAST FURNACE.

Trial No. 1.

46. On the 17th of March the wheel being complete, the water was put on and worked well, there being no defect in this part of the machinery nor any short coming of water, the water being much in excess of what was actually required; the blowing apparatus was still not quite completed, but was finished on the 22nd of the month.

47. The furnace having been heated up to the proper heat by wood and charcoal, the charges of ore were put in on the 23rd and on the following day the blast was put upon the furnace for the first time.

48. For some time the whole of the machinery worked well, but the pressure of the blast was not more than $\frac{1}{2}$ lb. on the inch, as near as could be estimated without a proper guage; this was low but sufficient, there being evidently an escape of air in the air-chamber and wooden pipes; gradually as the blast continued the leakage became greater, and the power weaker until it was as low as $\frac{1}{4}$ lb. on the inch; this was an insufficient blast for the proper working of the furnace as it was charged, and it was therefore considered advisable to take off the blast and withdraw the charges in the furnace in preference to allowing it to go on and thereby run the risk of choking up the hearth with imperfectly smelted iron, the taking out of which would have damaged the furnace materially.

49. During the greater part of the time the blast was on, the whole of the materials appeared to work well together and when the fire was reduced

a quantity of properly smelted iron was taken out from the bottom of the furnace or hearth, but too small in quantity and not sufficiently collected together to have found its way out at the tap-hole had the furnace been tapped.

50. During the time the furnace was being cleared out, steps were taken to remedy the defective blast apparatus, by doing away with the air chamber, where the air leaked most, owing to the shrinking of the wooden lining, and connecting the cylinders with the blast pipes by the addition of another large pipe and branch pipes; this having been completed and the pipes well turned and recaulked with hemp prevented the escape of air.

51. The iron taken out of the furnace was found to be of good quality. Pieces of what is known amongst workmen by the name of keosh, that is highly carburetted iron, were taken out, a certain indication that the yield of iron will be of very good quality; the lumps were collected together and readily remelted in the small cupola, with a little fan-blowing apparatus, which had been erected for making the brasses required on the works; the iron was very easily remelted and flowed out in a very liquid state into several small pigs, which when fractured showed them to be iron of the very best quality, known in the trade as "No. 1 Grey metal pigs first quality."

Trial No. 2.

52. As soon as the blowing apparatus was again put into order, the furnace was reheated and charged, and on the 13th of the present month (April) the blast was again put on, and was this time found to be upwards of 11¹/₂ pressure as nearly as could be estimated, but more intermittent than before. During the first twelve hours the whole of the materials worked well together as heretofore, and the machinery performed its part properly. About this time the cinder began to come down quickly and not in a very liquid state, probably owing to some small disproportion of lime used as the flux, and it required active exertions to keep the fore hearth clear. This was done for some few hours, and the cinder flowed over the dam but not very freely. The proportioning of the lime and other furnace materials can only be ascertained by actual practice with the furnace, and the proportions require changing frequently just as the furnace works, according to the judgment of the keeper. The altering of the proportions

from time to time does not necessarily involve the stopping of the furnace every time but simply altering the charges above, keeping the hearth and twyers clean, by raising the cinder with heavy crowbars.

53. This requires an amount of manual dexterity and practical acquaintance with the subject, which can only be acquired by a long apprenticeship to the business of a furnace-keeper; there being but one such man on the works, he continued to exert himself until quite exhausted; with the aid of Native labourers, by whom the work was kept going for several hours, but from the amount of physical exertion required and the heavy nature of the implements, together with the fierce character of the work to which they were quite unaccustomed, and being altogether untrained, they were unable to keep the furnace in proper order. After it had been kept going for about twenty hours, the furnace was tried to be tapped, but the metal was too far back and too small in quantity to find its way to the tap-hole. The first tapping is generally at the end of twenty-four hours, more or less, according to circumstances, during which time the work of keeping it in order is generally by far the most difficult; by and bye when the furnace is fairly in operation and the proportions of lime, iron-stone and fuel have been well ascertained, the liquid cinder flowing freely over the dam, then the keeping of it in order is easier; if the furnace could by any means have been kept properly at work and in order up to the end of the twenty-four hours after the blast was put on, and the first cast had been taken, it might then have been continued a little longer, possibly one or two days, but this would have been the utmost limit that could have been done this season, without the aid of a few additional properly qualified smelters. The qualifications of the Natives as smelters have not yet been properly tested, but from what has been seen of them, and from their previous knowledge and their observations and remarks during the progress of the experiments, it is believed that they will ultimately become very fair workmen, but in any future works undertaken it would be exceedingly injudicious to depend on them for working at first; it would be better and more prudent to incur the expense of bringing out a sufficient number of European smelters accustomed to the work, who if well selected and good useful men in other departments as well, could, when the Natives were trained to take part in the work, be the means of extending the number of furnaces and other works; any short coming

in respect of European workmen at the outset would in the end prove to be a false economy.

54. The iron taken out after the second trial was the same as the first, the furnace having sustained no damage.

CONCLUDING OBSERVATIONS.

55. In the General Summary of the Preliminary Survey of the Bhairub Iron Fields, from the Golah to the Ganges, it was estimated that the number of blast furnaces that could be kept in operation by the forest fuel was two hundred. This is however by no means the maximum that might be kept in operation by a proper management of the forests, but the introduction of an important manufacture like that of iron would of itself create an increased demand for timber which would require to be supplied from the forests. The number therefore that might be judiciously erected is sixty, and placed at the following localities—

56. Ganges,	-	-	-	6 Furnaces.
Ditto,	-	-	-	Rolling Mills.
Lal Daug,	-	-	-	2 Furnaces.
Kotdwara,	-	-	-	4 Furnaces.
Luna River,	-	-	-	4 Furnaces.
Choulchorree,	-	-	-	2 Furnaces.
Ramgunga, near Boxsur, &c.,	-	-	-	6 Furnaces.
Kalagurb,	-	-	-	6 Furnaces.
Ramgunga,	-	-	-	Rolling Mills.
Ramnugger and along the Kossilla,	-	-	-	12 Furnaces.
Kossilla River,	-	-	-	Rolling Mills.
The Kitcheree,	-	-	-	4 Furnaces.
The Dubka,	-	-	-	2 Furnaces.
The Boor Dechource,	-	-	-	4 Furnaces.
Dechouree,	-	-	-	Rolling Mills.
Loha Bhur Bhur,	-	-	-	2 Furnaces.
Tho Golah Huldwanee,	-	-	-	6 Furnaces.
Huldwanee,	-	-	-	Rolling Mills.
 Total,	-	-	-	60 Furnaces. 5 Rolling Mills.

57. The capabilities of the country east of the golah have not yet been clearly ascertained ; fuel and iron-stone are known to be abundant.

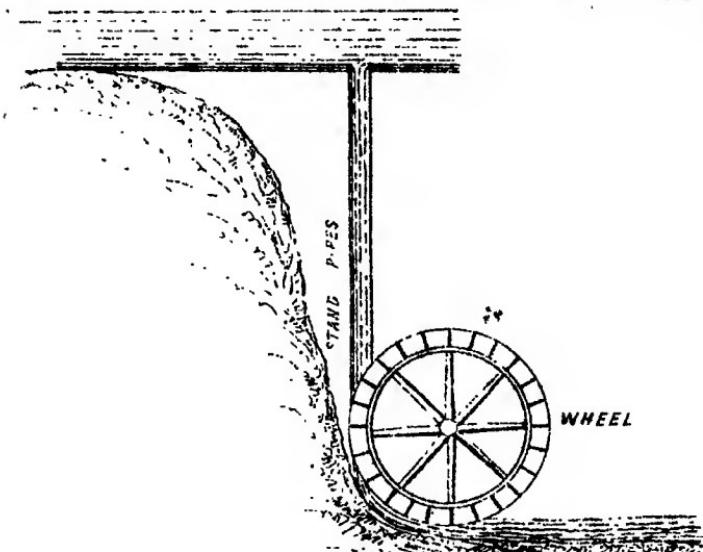
58. During a part of the year the climate of the Bhabur has the reputation of being unhealthy ; whether it is more so than any other country would be with dense forests, the result of heavy periodic rains and a hot climate is doubtful ; even temperate climates are known to have been and are still unhealthy in some parts of the world under similar circumstances ; on the establishing of works however some caution would be necessary in this respect.

59. Dechouree, from its comparatively elevated position and consequent healthiness, appears to be one of the best localities for commencing works ; the chief defect urged against this place is the limited quantity of water in the River Boer during a month or two in the hot season.

60. In a former Report, dated November 14th, 1855, the question of water supply at Dechouree was discussed, and the possibility of having to use auxiliary steam-power was referred to. After the most careful enquiry on the ground from land cultivators, and from actual observation of the stream, it is believed that the stream at the head of the present gools or water-courses is never less than twenty feet per second in the driest time of the year, and a little further up the river it is even as much as twenty-five to thirty cubic feet per second. The river is chiefly supplied from springs, and the body of water in the river varies at different parts according to the retentive character of its bed or otherwise. With such a supply of water very large works might be established by proper arrangements.

61. The construction of reservoirs has been suggested to make up for any deficiency of supply of water. Several places exist where such reservoirs might be constructed of large dimensions, where, if the ground was not sufficiently retentive, it might be puddled with clay. The construction of such reservoirs would require to form part of a well devised and carefully considered plan to be of any use. They would add but slightly to any continued power that might be required, such as for blast furnaces, but by being allowed to accumulate by night, the water would be available for driving rolling mills, lift and tilt hammers, and such other machinery as need only be worked by day.

62. A great deal may also be done with a small quantity of water, by bringing it down upon wheels by means of high stand pipes—thus:



With wheels constructed on this principle a very great amount of power is obtainable when there is only a small supply of water, and the high velocity which they acquire renders them peculiarly well adapted for driving rolling mills. This kind of wheel differs from the turbine, and suggested itself to me during the progress of the works.

63. A small experimental wheel on this principle was erected for driving the fan blast to the smith's forge and little cupola erected for melting brass. It performed seventeen revolutions per minute, with a small supply of water, and though rudely and roughly put together fully exemplified the principle. Steam-engines have been made upon a similar principle in England for several years and have been highly approved. The above plan for a water wheel has, I have been informed, been recently patented in England.

64. Assuming however that the water is as low as ten cubic feet per second, still a very great deal may be done with it, and that the river is quite dry every seven years as stated by Mr. Ex-Commissioner Batten, even then it would not be necessary to adopt steam as a motive power until steam-engines can be made on the spot; the stoppage of steam-engines for repairs and renewal of boilers would be quite equal to the

stoppage from any deficiency in the supply of water. The longer steam power can be dispensed with the better, simply because of the fuel. Coal can only be useful as fuel; wood is useful for very many other purposes. It is true that the waste heat of the furnaces can be made use of, but this involves complicated arrangement of the works.

63. The objections with regard to water power would not arise if the works were commenced on the banks of the Kosilla or Gola, where the quantity of water is unquestionable, and the furnace materials are quite abundant. These localities are said to be less healthy than Dechouree. The superiority of the latter place cannot however be so very great, and it would undoubtedly be more prudent and advisable to run the risk of having to suspend the works for one or two months in the year than to incur the expense, risk and delay of importing and erecting expensive steam machinery.

66. Under any circumstances it would be most desirable to have branch works a little way into the interior of the hills, the Agar District near Ramgurh, being the nearest to the plains, and well supplied with iron-ore, wood and water power, would be the best. Such branch works would always be available, in the event of the works in the Bhabur having to be suspended for a short time, from any apprehension of unhealthiness or short-coming of water; they would also be valuable for removing the European workmen, who could reside there during short periods occasionally for change of air, being thus usefully employed instead of remaining entirely idle.

67. In the establishment of new works of this kind, their success will depend rather upon the excellence and completeness of the arrangement made amongst the Native labourers, (on whom will fall the great bulk of the work) and in the selection of European workmen than upon any short-coming of suitable materials or want of facilities. Very few countries possess so many local advantages of every kind and in such superabundance, to reject any one of which would show a want of judgment. There are doubtless some risks to be run in the commencement, and some errors will be committed, any thing like a failure however of the works as a commercial speculation will most certainly be the result of mismanagement or missapplication of capital, from an erroneous conception of the proper mode of carrying out the works.

68. The building of the furnaces and other works will be found to be the least difficult part of the whole enterprize. When one or two fur-

naces are fairly in operation, it will then entirely depend upon the energy displayed in extending the works, and the amount of capital forthcoming to carry them out, to the extent that the requirements of the country demand.

Wm. SOWERBY, *Asso. Inst., C. E.*
Engineer in charge of the Works.

NYNEE TAL, }
April 25th, 1856. }

ABSTRACT OF EXPENDITURE ON ACCOUNT OF THE
WORKS AT DECHOUREE.

	*	Rs.	Aa.	P.
Building of furnace and water-wheel,	-	5,854	6	2
Making fire-bricks,	- - - - -	419	13	3
Making red bricks,	- - - - -	22	12	11
Calcining ore,	- - - - -	12	13	10
Lime,	- - - - -	732	3	8
Materials, brass, tar, hemp, &c.,	- - - - -	808	4	9
Building workmens' house and tool house,	- - - - -	198	7	3
Charcoal making,	- - - - -	803	10	7
Making roads,	- - - - -	202	7	11
Tram-way,	- - - - -	330	5	0
Making bund and repairing water-course,	- - - - -	254	11	4
Sundries,	- - - - -	833	14	0
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Total Rupees,	- 10,478	14	8	
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NOTE. The whole of the works have cost at least 25 per cent. more than they should have done for want of good tools, good workmen and previous preparations.

W. SOWERBY,
Engineer in charge of the Works.

A plan of the furnace and machinery accompanies this Report.

Also—

A specimen of keesh.

A pig of iron cast after the first experiment.

A lump of iron out of the furnace after the second experiment.